THE ENGINEER

A Seven-Day Journal

The Iron and Steel Industry

WHEN the debate on the address in reply to the King's Speech was resumed in the House of Commons on Monday last, an opposition amendment was discussed regretting "proposals relating to the iron and steel industry." In moving the amendment, Mr. G. R. Strauss said that the opposition intended to resist at every stage any proposal to remove from the authority of Parliament the broad, effective and positive control which it now possessed over the iron and steel industry of this country. The Minister of Supply, Mr. Duncan Sandys, spoke for the Government. He said that the Government remained sincerely convinced that the decision to nationalise the iron and steel industry was a very grave error and regarded it as a duty to restore conditions of free enterprise without which the industry would not be able to make its maximum contribution to the national output. It was clear that steel was going to play a major part in the efforts which had now to be made to restore the balance of payments and re-establish the country's solvency. If nationalisation were to continue, the Minister stated, the Iron and Steel Corporation would have to become a great deal more active and gradually, but surely, the units of the steel industry would inevitably become less and less capable of independent initiative and action, and less and less flexible. The Government had been considering what action should be taken to stabilise the position in the interval between now and the time when a bill to annul the Iron and Steel Act would be introduced. After consultation with the Corporation the Government had decided to issue a statutory direction to the Corporation under powers conferred by Section 4 of the Iron and Steel Act. By that direction, Mr. Sandys explained, the Corporation could not take, without the written consent of the Minister of Supply, any action in the exercise of its functions which would result in "any alteration in the financial structure or management of any publicly owned company or of any other company under the control of the Corporation, or the sale or disposal of any part of the undertaking or securities held by any such company." It was hoped, the Minister said, that that would be enough to hold the position pending the introduction and passing of legislation.

Railway Accidents in 1950

THE report of the Ministry of Transport's chief inspecting officer on railway accidents in Great Britain during 1950 was published at the end of last week. The accidents have been classified in three groups: train accidents, movement accidents which were associated with the movement of railway vehicles exclusive of train accidents, and non-movement accidents, or those which occurred on railway premises and were not connected with the movement of any railway vehicles. The report says that in the year 1950 there were 1156 train accidents reported, compared with 1176 in 1949 and with a yearly average of 1250 between 1946 and 1950. Among last year's train accidents there were twenty-three in which forty people were killed, including eleven passengers and eight railway servants. The number of passengers injured in train accidents was 448. The report summarises briefly the causes of the more serious train accidents which occurred last year and says that though 1950 was not so fortunate as 1949 in train accident fatalities, the standard of safety generally was maintained in a year which was disappointing in many ways to all concerned with operation and maintenance. The drift away from railway employment was accentuated last year and reference is made by the chief inspecting officer to the effects of the serious deficiency of permanent-way staff, when everyone had hoped that general restoration of the track to first-class condition would now be well on the way if not complete. At the same time, the report notes, the demands on the country's resources in skilled manpower and materials have become more insistent and are retarding the renewal of equipment and are preventing or curtailing the realisation of planned measures to improve efficiency and safety, as well as the reconstruction of out-of-date premises of all kinds, which would result in better conditions of work. The psychological effect of present conditions, the inspecting officer suggests, cannot be disregarded and more care than ever is therefore necessary to ensure that safety is not impaired.

The Cycle and Motor Cycle Show

SINCE Saturday last the twenty-sixth exhibition of cycles and motor-cycles, organised by the British Cycle and Motor Cycle Manufacturers and Traders' Union, has been open at Earl's Court, London. It will close to-morrow, November 17th. The exhibition occupies the whole of the ground floor, there being exhibits from twenty-eight bicycle, thirty-three motor cycle and 127 component and accessory manufacturers. This year, for the first time, eighteen exhibitors of motorised bicycles form a separate and outstandingly popular section of the exhibition. It is estimated that between 100,000 and 150,000 such machines are now in use in this country as a result of the growing status of this economic form of travel. The detail design of these bicycle motors displays considerable ingenuity and embodies some unusual technical details. The rotary valves in some and the balancing of certain others are particularly noteworthy, as is the extensive use of aluminium alloys in their construction. Motors can either be bought for attachment to the bicycle or the bicycle and motor are available as one unit. Various drives have been adopted and the engine located accordingly. A common method of transmission is the direct drive through a carborundum roller on the tyre; another design exhibited employing an endless "V"-belt in conjunction with an auxiliary rim on the rear wheel. Others employ either chain drives or epicyclic gearing. One other unit consists of a single cylinder rotary engine mounted in the hub of the rear wheel. Most of these two-stroke engines have capacities ranging from 31cc to 40cc and develop about 0·7 h.p. at maximum engine speeds of between 3000 and 4000 r.p.m. Weights are mostly less than 16 lb and cruising speeds about 20 m.p.h. The light motor-cycle class is again well represented and the exhibition includes two scooters, popular on the Continent, and two miniature three-wheeled cars.

The Organisation of Industrial Research

AN international symposium on the organisation of scientific and industrial research has been taking place in London this week. It was attended by delegations from ten European countries and from Canada and the U.S.A., and was arranged to coincide with a visit to this country of an intra-European mission, which has been touring eight countries to study research organisation and methods of applying research in industry. The symposium included papers on co-operation in research, sponsored research, the administration of research and the application of results. At the official opening of the symposium last Monday morning, the Lord President of the Council, Lord Woolton, welcomed the delegations. He said that no country had a monopoly in scientific discovery but each country had a need to ensure that conditions favourable to fundamental research were provided. With applied research and development, however, circumstances were different. Industry itself must take the brunt of applied research and development, but in this country it was well-established policy through the system of industrial research associations to undertake a considerable proportion of applied research as a joint enterprise between Government and industry. It was in that field of applied science, Lord Woolton suggested, that co-operation between nations became so desirable. Sir Ben Lockspeiser, F.R.S., secretary of the Department of Scientific and Industrial Research, also spoke at the opening session, saying that the world we saw to-day had been largely shaped by science. We lived in a technological civilisation which had given us our present standard of living. We could not hope, Sir Ben asserted, to maintain it on any other basis and we could not expect to improve it unless science and technology ran freely through the veins of industry.

The Jointing of Aluminium

ON Tuesday, November 13th, the Aluminium Development Association held a symposium on "Welding and Riveting Larger Aluminium Structures," at Claridges Hotel, London, and the Association headquarters. Its purpose was to summarise the present position and future possibilities in view of the increasing use of aluminium for larger structures, especially in civil and structural engineering, motor engineering and shipbuilding, which has created problems related to the jointing techniques required for thick plates and sections. The guests were received by the president of the Association, Mr. Austyn Reynolds, and the vice-president, Mr. H. G. Herrington. At luncheon, Mr. Reynolds, in a brief speech of welcome, outlined the purpose of the symposium and mentioned several of the technical bodies engaged in practical research. On the question of aluminium supplies he expressed the view that they would be adequate to meet future demands. During the morning session at which Dr. Maurice Cook presided, two papers were read on "Recent Researches on the Arc Welding of Thick Aluminium Alloy Plate," by Mr. P. T. Houldcroft, Mr. W. G. Hull and Dr. H. G. Taylor, and "Practical Aspects of the Argon Arc Welding of Aluminium Alloys," by Mr. J. R. Handforth. Dr. C. J. Smithells took the chair in the afternoon, when the following papers were presented: "The Properties and Driving of Large Aluminium Alloy Rivets," by Mr. J. C. Bailey, and "The Design Characteristics of Aluminium Riveted Joints," by Professor S. C. Redshaw. After the reading of the papers the guests adjourned to the headquarters of the Aluminium Development Association, where they witnessed demonstrations of argon arc welding, including the latest consumable methods, and were able to examine a large number of samples of welded and riveted joints, the most impressive example of welding technique being an all-welded aluminium alloy davit. The programme also included the showing of a colour film on argon arc welding.

The End of an Era

By EDWARD H. LIVESAY

No. I

IT is safe to say that the day of the steam locomotive in North America is drawing to a close. The more than century-old supremacy it has enjoyed there has been not merely challenged; battle has been joined and the issue definitely decided in favour of the diesel-electric engine. The writing appeared on the wall about fifteen years ago, when this form of motive power, in twin-unit guise, was first tried in long-distance passenger service on the Burlington line with the "Zephyr" train and proved itself to be a practical method of haulage, capable of large-scale adoption and development. Several other railway companies then began experimenting with similar locomotives, but before and during the war the adoption of diesel-electric power, while becoming increasingly common, was tentative, though there was a definite trend in that direction. More and more railways showed willingness to give it a trial, first in passenger and then in freight service, twin-unit engines being generally used for the former and three or even four units in the latter case, coupled together and controlled as one. After the war the trend became more obvious and recently it became a surge, for now scarcely any steam locomotives are being built in the United States for home use. Illustrating this drastic turn over, during the first ten months of 1950, only one new steam locomotive went into service in North America on Class "I" railways, but 1915 diesel-electric engines took up their duties in the same period. Again, in the early months of this year, 1496 diesel, nineteen steam and eight electric locomotives were on order for Class "I" railways. These figures confirm the truth embodied in the title of this article—they are taken from the *Railroad Magazine*.

This revolution in railway motive power, for it is nothing less, has now spread across the imaginary line separating Canada from her neighbour to the south. This, of course, is often the case, whether for good or ill being sometimes a moot point, and certainly it is apt to be so where railway equipment and methods are concerned—what is adopted south of the 49th Parallel sooner or later becomes standard practice north of it. It, therefore, came as no surprise when two years ago the C.P.R. announced that it had built its last steam locomotive, No. 5935, 2–10–4 "Selkirk" type, for operation in the mountains of British Columbia. The fiat went forth that in future only diesel-electric engines would take to the company's metals and, by putting this edict into effect on the Esquimalt and Nanaimo Railway, where thirteen diesel-electric locomotives now do the work previously carried out by twenty-four steam engines (November/December, 1950, THE ENGINEER), the C.P.R. showed it had the courage of its convictions. On that line, at any rate, the day of the steam locomotive is not merely nearing its end—it is definitely over. The C.N.R., too, the other great Canadian transcontinental system, following suit, has also recently announced that it will only build diesels in future. It is, therefore, with regret, but not surprise, that I have seen the prediction, hazarded more than once in previous articles, so soon verified—the day of the steam locomotive of basic design is nearly over in North America.

For this reason alone, if for no other, I should have been justified in taking, during this spring of 1951, what may well be my last "fact-finding" journey over C.P. metals in the cabs of various types of steam locomotive that at the moment of writing are still hauling their heavy loads through the mountains and canyons of British Columbia, over that route of which I have become so fond—my affection extending to the locomotives as well as to their environment! I felt, too, that if the excursion were to be made 'twere well it were made quickly, for though I do not know just when the change-over from steam to internal combustion will take place in its entirety, I understand it will begin some time this year, and in the mountains, so evidently the sand in the glass is trickling fast. When next I find myself with "The Dominion," winding along beside the rushing waters of the Bow, the Kicking Horse or Columbia Rivers, it may well be that I shall hear the muffled rumble of a diesel motor coming from ahead instead of the harsh roar of a "Selkirk," and that in place of the rhythmic swing of great connecting-rods I shall see—nothing! A saddening thought indeed to anyone born and brought up in the age of steam, but one that must be accepted as symbolic of the times in which we live.

One of the first effects of this will be the displacement of numerous "pushers"—though they are "pushers" only in name on passenger trains; they pull—that now double or even triple-head heavy trains from Revelstoke up to the summit of the Selkirk Range at Glacier, the western end of the 5-mile Connaught Tunnel; up the western flank of the Rockies from Golden to Leanchoil, and from Field to Stephen. I shall then have to go farther afield to the prairie east of Calgary, to renew acquaintance with No. 5935 and her sisters, where they are to be used on heavy freight trains, the bridges west of Revelstoke to Vancouver not being strong enough to carry the massive "Selkirks," with their 330 tons of thew and sinew.

Apart from this coming motive power *bouleversement*, another reason induced me to make the trip to Calgary. It is thirteen years since I first travelled in locomotive cabs over these unique divisions and recorded my impressions in THE ENGINEER (March, 1939), and nine since I made my last journey, in this instance from east to west only. During the succeeding period many changes have taken place in both locomotives and cars, so it is only fitting that what is being used and done in British Columbia during 1951, nearing the end of the steam era, should be placed on record, when much that we have been familiar with so long will soon be a thing of the past. For instance, the 2700 "Pacifics" have gone, and the 2300 and 2800 "Hudson" classes reign in their stead; the 5920 "Selkirks" now share the honours in the mountains with the older 5900s; passenger accommodation, too has improved, and so on. In any case, the work of all these locomotives deserves a place in railway archives before it is pigeon-holed and forgotten.

The 1950–51 winter in Southern British Columbia was unusual, in that it reserved most of its fury for the time when everyone thought it was nearly over and spring just round the corner. Objecting, as I do, to cab travel in below zero temperatures—or any kind of travel, for that matter—I put off the journey until I felt sure of fine weather, only to arrive in Vancouver on March 4th, simultaneously with the very worst blizzard of the winter, awaking next morning to find a foot of snow had fallen in the night, and to hear ominous reports from C.P.R. officials that it had blanketed British Columbia, blocking the main line with "slides" in more than one place, and disrupting nearly every schedule. Regretting the necessity, they feared that my projected tour would have to be postponed until things cleared up, with which dictum I quite concurred, as I had no desire to make a nuisance of myself by intruding when enginemen and train crews had something far more important to do than bother with a supercargo in the cab; in any case, the prospect of making a journey of 1200-odd miles under Polar conditions had no attraction for me. I therefore cheerfully

FIG. 1—C.P.R. STATION AT VANCOUVER, B.C.

withdrew back across the water to Victoria, to wait for the clouds to roll by, and for a wire that was promised as soon as conditions were more favourable. This notification came a couple of weeks later and once more I set off for the mainland, per SS "Princess Kathleen," looking forward to a pleasant, unobstructed excursion right through to Calgary. But "the best-laid schemes of mice and men . . "; it turned out we had been unduly optimistic. It was not for me to see the distant view—the washouts, slides, blizzards, and whatnot—that were to hamper my passage and disrupt my schedule, though this very fact made the journey more interesting and worth recording. So with everything as I thought cut and dried, I disembarked at Vancouver in good time to leave again on whatever locomotive might be taking "Train No. 2" out of the city at 10 a.m.

In the early months of the year two Canadian Pacific transcontinental trains leave Vancouver (Fig 1) daily, "No. 2" and "No. 8," "The Dominion," the latter running in two sections, if necessary. "The Dominion" is the faster and more important of the two, stopping only at significant points, though "flagging" may add to the number of stops. "No. 2" is willing to stop anywhere, and does so unless it is not flagged, in which case it by-passes places which, by Euclidian definition, have position but no magnitude, and there are many such in B.C. I chose "No. 2" out of Vancouver, because it covers the first half of the 642 miles to Calgary, through the Fraser and Thompson Canyons, by daylight, and I could stop off at Sicamous for the night; the scheduled arrival time there was 10.40 p.m. Cab travel after dark is to be avoided as far as possible; it is boring, and note-taking is hampered; besides, sufficient unto the day are twelve hours and forty minutes on a locomotive—in fact, more than sufficient in my opinion. "The Dominion" leaves Vancouver at 7.30 p.m., so whichever train one takes it means that half the journey must be done at night if one travels straight through to Calgary. "The Dominion" emerges into daylight about Revelstoke, at the foot of the Selkirks, and "No. 2" plunges into darkness at Kamloops, so one misses the heaviest work and most of the glorious mountain scenery. I wanted to take notes over the whole route and miss nothing; hence the planned interval at Sicamous.

Train "No. 2" got away at 10 a.m. O.T., the engine being No. 2390, (G3g class, 4–6–2 like No. 2356 in Figs. 2 and 3), built in 1942, and the load ten cars, say, 700 tons. The chief dimensions of this class of locomotive are as follows:—

Cylinders	22in by 30in
Driving wheels	75in
Steam pressure	275 lb
Tractive effort	45,300 lb
Weight on drivers	89 tons
Weight of engine	144 tons
Weight of tender	132 tons
Grate area	65 square feet
No. and diameter of arch tubes ...	four 3½in
No. and diameter of tubes	thirty 2¼in
No. and diameter of flues	140, 4in
Length of tubes and flues	17ft 7in
Heating surface, t. and f.	2,885 square feet
Heating surface, arch tubes ...	33 square feet
Heating surface, firebox	258 square feet
Heating surface, superheater ...	1,475 square feet
Heating surface, total	4,651 square feet

"Elesco" feedwater heater. Multiple throttle. Air-operated reverse. Leading truck with roller bearings.

The enginemen were Messrs. Lee and Tombs. Train starting rules are stereotyped in North America; shortly before train time the conductor (*Anglice*, guard) hands the train orders up to the engineer (driver), who reads them to the fireman, after which they are hung on a hook for reference at any time. The communication system (with its air whistle in the cab, by means of which the conductor signals to the engineer) and the brake train pipe are tested; then, shortly after the train has moved off, the brake is momentarily applied and released as a further test. It has often seemed to me, when riding in British cabs, that some similar method of guard-driver communication might be worth adopting; it could prevent accidents.

No. 2390 was not booster equipped, but with dry rails the start was easy, and we were soon running at speed past an endless succession of docks, piers, grain elevators, and waterside buildings that line the south shore of Burrard Inlet, Vancouver's great harbour, across which lies the growing suburb of North Vancouver, with a range of snow-capped mountains in the background. Certainly Vancouver's setting is very fine. The location of the railway, following the shore line closely, is often a nuisance to waterside establishments, as access to them calls for level crossings over several tracks, main line and sidings, but, of course, when the line was plotted sixty-five years ago the easiest way to the terminus was chosen, and that was along the shore. There were no "shore establishments" in those days, only dense forests; a water level route was followed as far as possible, with industry following later, the waterside being the logical place for that, too. It is one instance out of many where Canadian practice follows American; in the U.S. the railway often came first, trade and commerce coming after and settling its housing problem as best it could; Canada followed the star-spangled manner. But to resume. At Port Moody, 13 miles, the original terminus of the C.P.R. is passed and the line swerves south-east, crossing Pitt River by a longish bridge, leaving the eastern end of Burrard Inlet and picking up the Fraser at Hammond.

A third seat is placed behind the fireman's on Canadian locomotives; it is used by the head brakeman when the engine is being employed on freight service, and comes in useful for an observer at other times. The sliding window, with its adjustable wind-deflecting strip of glass attached to the rear frame, projecting at right angles, is generally kept open unless the weather is very severe, as otherwise the vestibule cab, totally enclosed, would get stuffy, despite two ventilating openings in the roof. Has this window strip become a standard fitting in England? I noticed it on several locomotives ridden there before the war. If it has not, it should be adopted as such. A padded arm rest is another amenity universal west of the Atlantic, but I never noticed it in Britain. On "Commonwealth of Australia," hauling the "Flying Scotsman," the firemen, Floyd and Kinnear, had simulated something of the sort with a home-made strip of wood filling in the slot along which the window slid. Better than nothing, but the simulation was transparent; it was a poor substitute for a comfortable padded arm rest. I do hope little things like this will be given attention upon Britain's "Standard" locomotives. They do not cost much, but add a good deal to cab comfort and the satisfaction of the men with their job.

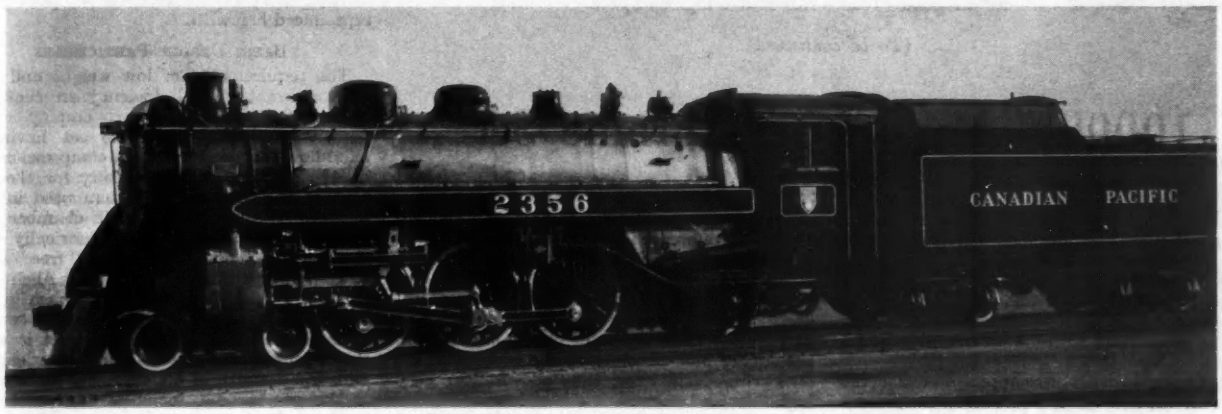


FIG. 2—ENGINE NO. 2356, G3G CLASS—4-6-2

The track is very sinuous along Burrard Inlet. When laid out, it must have followed the path of least resistance, and there are no gradients worth consideration, though the trend is imperceptibly upward, towards the Coast Range. This is the Fraser Delta, composed of mud brought down by the great river from the mountains through the centuries and deposited near its mouth, in the way so many rivers the world over have done, in this case to make lush farm lands and good grazing for the cattle from which comes the famous "Fraser Valley" butter. Sometimes, as in 1948, the Fraser wearies of welldoing, rises above the dykes that hem it in, by which its bounds are set, and floods tens of thousands of acres, to the acute discomfiture of the farmers and their stock and all who live and do their business beside these great waters. Then the Government, true to type, shuts the door after the steed is stolen, by spending millions of dollars strengthening and raising the dykes, repairing those that have burst, and after resting from its labours loudly proclaims that such a calamity cannot

possibly happen again. It probably can—and most likely will some day—but, of course, the other party will be in power then. I should need more than that assertion to comfort me if I lived in the Fraser Valley and saw the water level remorselessly climbing, climbing up the banks, raised by the spring run-off. I should fear and respect the river a good deal more than I should respect Governmental assurances. In any case, the actions of both are unpredictable, but the former is indifferent to the voter's prayers and threats.

The riding of No. 2390 was decidedly on the rough side, unless I was out of practice, not having ridden a "steam locomotive of basic design" for several years, so I appealed to Engineer Lee for his opinion: it was confirmatory: "No, it isn't at all good—rear truck springs want setting-up." The trailing truck was a "Cartazzi," similar to those on a Gresley "A4"; the C.P.R. is one of the few companies in North America that has used it to any considerable extent; it is to be found on several of their classes. At the next stop I got down to look at it, finding a good deal of wear in the sliding plates that control the lateral motion. I was not very fond of the "Cartazzi" in England, and said so in THE ENGINEER; it is excellent when in good shape, but maladjustment or wear seems to have a greater effect on its functioning than on the Bissell, radius-controlled and anchored to a central pin. Mr. Bowen, ex-superintendent of motive power, told me the "Cartazzi" was cheaper to construct and satisfactory "on engines not intended to run at the highest speeds."

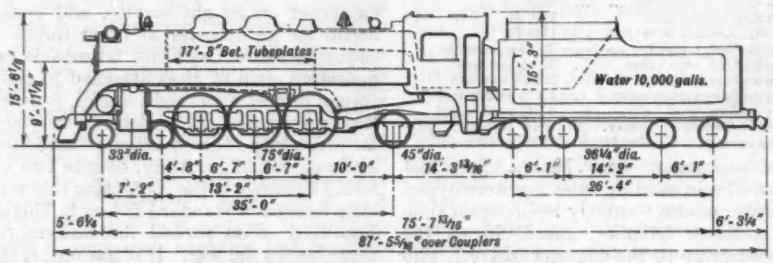


FIG. 3—OUTLINE OF G3G CLASS LOCOMOTIVE

(To be continued)

1000kW Marine Gas Turbine Set

No. I

THE potential advantages of compactness, light weight and low maintenance inherent with the gas turbine, in addition to those which it shares with the diesel, of self-contained operation and quick starting, led the Admiralty to consider the development of gas turbine driven alternators suitable for naval requirements.

At the same time, it was appreciated that the fuel consumption of a gas turbine in the present stage of development, especially when designed for maximum reliability and long operating life, is high compared with the diesel engine, although of the same order as the steam turbo-generator. It was therefore decided that a unit having a clearly defined naval specification for base-load operation should be made. Early in 1948 a development contract for a 1000kW set was awarded by the Admiralty to W. H. Allen, Sons and Co., Ltd., Queen's Engineering Works, Bedford, who have for long been engaged in the manufacture of steam turbo-generators for naval service. Work commenced immediately on this project, the company engaging a new team of gas turbine technologists and setting aside a section of their Biddenham works for the assembly of gas turbines and for the installation of special machine tools required for blade manufacture. In addition, it has built on behalf of the Admiralty a fully equipped and instrumented test house. The work has been greatly facilitated by a consultancy agreement between the Bristol Aeroplane Co., Ltd., and W. H. Allen Sons and Co., Ltd., which entitles the latter to design data, advice on production methods and the use of certain testing facilities.

The Admiralty specification was for a set of 1000kW continuous maximum rating with a 20 per cent overload for ten minutes, to be suitable for operation at all loads up to overload under temperate (60 deg. Fah.) or tropical (100 deg. Fah.) conditions, and capable of running satisfactorily in parallel with other steam turbo-alternators, the governing requirements being 2½ per cent speed change for 50 per cent load change and the ability to accept or shed 100 per cent load without operating the emergency gear. The fuel was to be diesel oil, Admiralty reference fuel B.310, and a maximum fuel consumption of 1·27 lb per kilowatt-hour under tropical conditions in the zone 60 per cent to 100 per cent power was specified. Total head pressures of 14·1 lb per square inch absolute at the compressor intake and 15·1 lb per square inch absolute at the power turbine outlet were called for, thus allowing for very high inlet and exhaust trunking losses.

The engine was to be entirely self-contained and to be as small as consistent with reasonable accessibility, the maximum height available being 7ft, and every reasonable opportunity was to be taken to reduce weight without sacrificing reliability. Shock loadings of 40*g*. upwards, 25*g*. downwards, and 15*g*. athwartships were specified.

Finally, a life of 100,000 hours was to be aimed at, this period being made up of 65,000 hours at 80 per cent power under temperate conditions, 33,000 hours at 80 per cent power under tropical conditions, and 2000 hours at full power under tropical conditions.

Our second illustration shows the 1000kW Allen gas turbine driven alternator as erected for testing at the Allen works. The lagged outer covers are removed to expose the compressor, turbines, air pipes, heat exchanger, combustion chambers, and instrumentation piping. On the left is shown the air intake trunking and the exhaust outlets are arranged on each side of the heat exchanger.

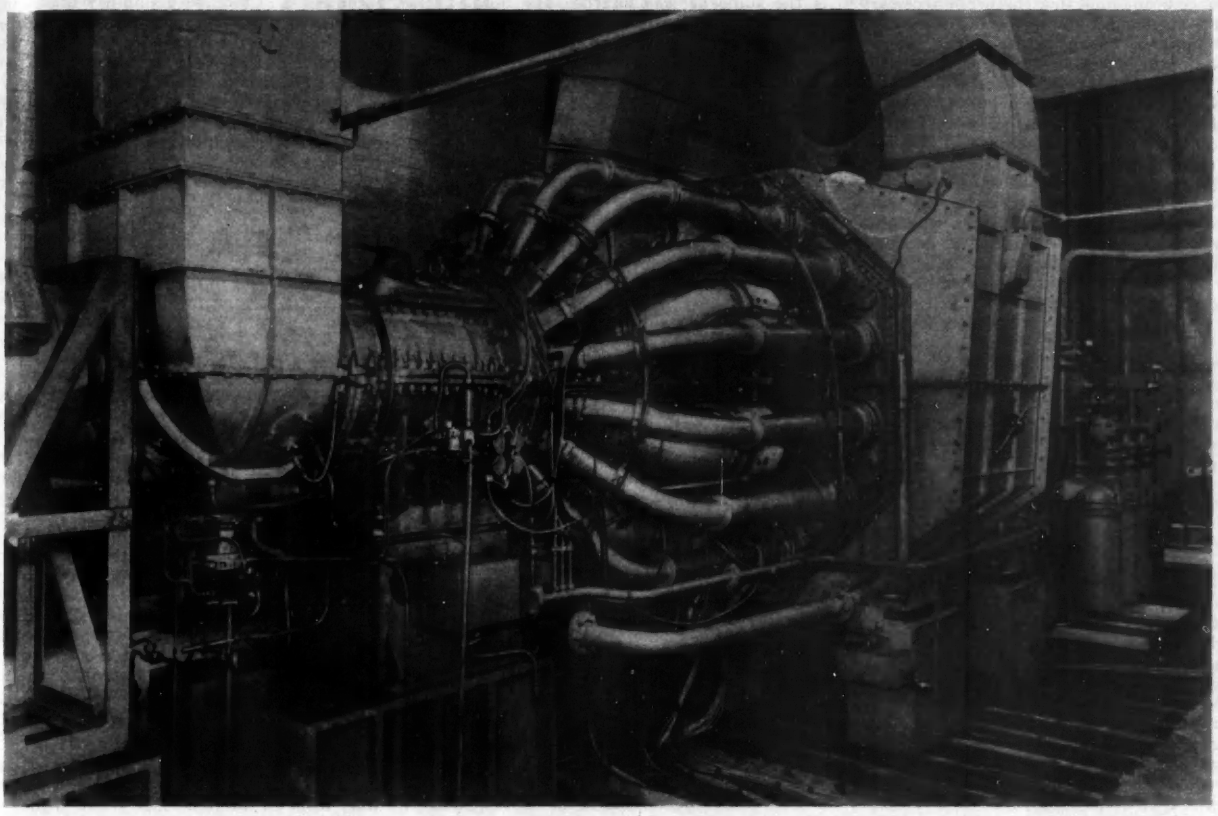
This gas turbine set without the heat exchanger, has now been on test since early this year. Full speed, full load and overload were achieved in the first series of tests with the minimum of mechanical "teething" troubles. During a recent visit to the Allen works we were able to see the set, which at that time was undergoing a routine overhaul. As a comprehensive series of performance, governing and endurance tests is still in hand, it is not intended to discuss its performance up to date at this stage. The present description relates only to the general design and construction of the set, which is illustrated on our Supplement drawing and on other drawings and photographs reproduced herewith.

BASIC DESIGN PARTICULARS

The requirements of low weight and space with reasonably good efficiency are conflicting ones, and it was decided to employ a comparatively simple open-cycle set having an axial-flow compressor with a compression ratio of 4½ : 1 and to adopt, mostly for the same reasons, the combustion system used in aeronautical turbines of a multi-chamber combustion system disposed symmetrically round the engine. It is fitted with a "free" single-stage power turbine driving the Allen alternator through Allen-Stoeckicht epicyclic gearing, and it incorporates an annular two-pass cross-flow heat exchanger. The set is within the required height of 7ft and has a length of 16ft and a width of 8ft 6in. The total weight of the gas turbine, including heat exchanger, but excluding alternator, is 8½ tons.

BOTTOM HALF OF COMPRESSOR CASING

1000kW GAS TURBINE ON TEST



The unit is without baseplate, a three-point mounting being adopted, and it is carried on resilient rubber mountings to minimise the effect of shock loading due to underwater explosions. Other details are tabulated below.

Main Particulars of 1000kW Gas Turbine

Continuous maximum rating at power turbine coupling, including fouling margin, b.h.p.*	1512
Estimated specific fuel consumption at C.M.R., lb/b.h.p./hr.	0·745
Estimated thermal efficiency at power turbine coupling at C.M.R., per cent	19·75
Mass flow at C.M.R., lb/sec	37
Maximum gas temperature under tropical conditions, deg. Cent.	700
Maximum gas temperature under temperate conditions, deg. Cent.	650
Compressor speed, r.p.m. approx.	8000
Number of compressor stages	13
Number of compressor turbine stages	2
Power turbine speed, r.p.m., approx.	6750
Number of power turbine stages	1
Alternator speed, r.p.m., approx.	1500
Number of combustion chambers	8
Heat exchanger thermal ratio, per cent	70

* The output stated is that obtained with the high inlet and exhaust losses specified. Without these abnormal losses the C.M.R. electrical output would be 1250kW (temperate conditions), whilst the thermal efficiency would be 24 per cent and the specific fuel consumption 0·625 lb/b.h.p./hr.

Component Weights

	Weight in lb
Compressor complete	3,360
Compressor turbine with inlet bends	2,604
Power turbine complete	1,232
Heat exchanger complete	7,280
Alternator and exciter	11,788
Alternator and gearbox baseplate	2,800
Gearbox	672
Epicyclic gears	504
Total	30,240

Construction

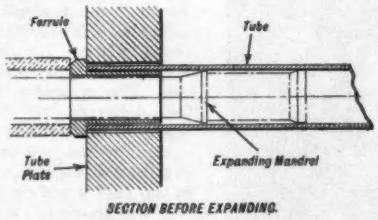
The mechanical design is based upon the component assembly principle, so that each assembly is removable from the machine independently of the others.

The compressor casing is split on the horizontal centre line and the top half is easily removable for inspection purposes without breaking any pipe joints. The centre bearing can be inspected by dismantling those air pipes connected to the top half of the casing and removing the top half casing, which is also split on the horizontal centre line. After removal of the compressor air delivery pipes and the combustion chambers the two turbines can be readily inspected by splitting the casing vertically between the compressor turbine and power turbine and moving the compressor, with its associated turbine, away bodily, while supporting its weight by an overhead crane. If necessary, either the power turbine or the compressor turbine assembly can be removed endwise as a unit for further dismantling.

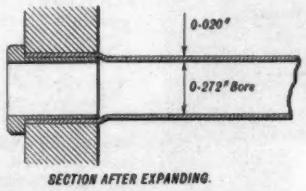
The gearcase is split horizontally and the epicyclic gear assembly can be removed vertically for inspection or dismantling.

The Compressor

The compressor has thirteen stages and was designed with half vortex blading of aerofoil section and a compression ratio of 4¼ : 1. The mass flow at continuous maximum rating is 37 lb per second and the compressor speed approximately 8000 r.p.m. In tests so far it has achieved an adiabatic efficiency of 86 per cent, being 2 per cent higher than the design figure. Each stage has seventy-six rotor blades of 13 per cent chrome stainless iron, the blades being machined integral with their roots.



SECTION BEFORE EXPANDING.



SECTION AFTER EXPANDING.

HEADER CONNECTIONS

The rotor blade profiles which were machined by Centrax, Ltd., are identical throughout the compressor, the length of the blade being appropriate to the stage as a common rotor root diameter has been adopted.

The rotor wheels are of 1 per cent chrome-molybdenum steel B.S. En. 19, the discs being secured to each other on the faces of the bosses by means of dowel pins, through which the torque is transmitted.

All blades are wired together in groups of ten for ease of assembly and are lightly located between the rims of adjacent rotors by means of grooves machined in the roots, which engage with a corresponding register on the discs. The assembly of the discs and blades is carried out with the axis of the rotor vertical.

The design of the rotor assembly aimed to keep the moment of inertia as low as possible in order to assist the speed governor during sudden load changes.

The complete rotor disc assembly and the shaft ends are clamped together by a special steel bolt passing through the centrally bored discs. Compensation for the differential expansion of the bolt and assembly is obtained through the inner and outer sleeves which surround the bolt. The outer tube is secured to the outlet end stub shaft by a nut and at its other end carries a screwed collar against which the corresponding end of the inner tube is butted. The bolt head bears upon the inner tube directly and passes through the rotor assembly and the centrally bored stub shaft at the inlet end, against which it is tightened with its nut.

Concentricity is maintained between the compressor disc assembly and the two stub shafts under all conditions of speed and temperature, since they are butted together on the faces with "Hirth" couplings.

The stator blades (eighty per stage) are of Monel metal rolled strip, of aerofoil section, cast into combined roots and spacers and secured in grooves in the support rings. The inner casing and support rings are of mild steel with a cast steel outer casing, split on the horizontal centre line.

Double-skin construction of the stator casing is adopted to ensure sufficient space for adequate

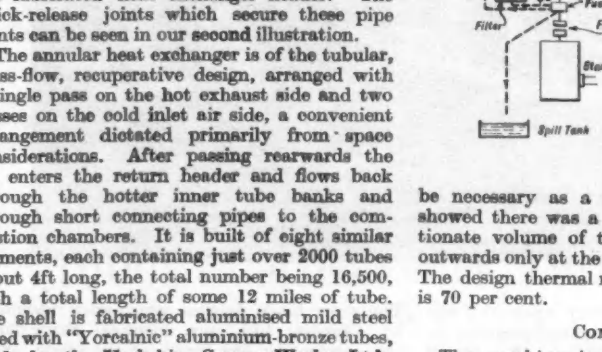
amounts of air blow-off in the event of surging during starting or sudden load changing, but it has since been found that this is not necessary. Our first illustration shows the bottom half of the compressor casing with special rig test inlet and outlet ducts.

At the compressor inlet end, a stub shaft of 1 per cent chromium-molybdenum steel is housed in a 3in diameter mild steel sleeve bearing, lead bronze lined. An oil baffle and labyrinth gland are interposed between the bearing and the end rotor wheel. Secured to the stub shaft at its other end and enclosed in the fuel pump drive casing is a pinion, through which are driven the compressor tachometer generator and the Lucas fuel pump, type "B." This pinion also connects through a clutch and driving nut to the starting motor.

Heat Exchanger

After leaving the straightener stator blades the compressed air enters a mild steel discharge annulus, fitted with cornering vanes, which is supported from the discharge casing, also of mild steel. From this annulus the air is led outwards in sixteen diffuser pipes, radially disposed, is turned in bends of constant area cross section into further diffuser pipes disposed horizontally around the turbine which lead to the fabricated heat exchanger header. The quick-release joints which secure these pipe joints can be seen in our second illustration.

The annular heat exchanger is of the tubular, cross-flow, recuperative design, arranged with a single pass on the hot exhaust side and two passes on the cold inlet air side, a convenient arrangement dictated primarily from space considerations. After passing rearwards the air enters the return header and flows back through the hotter inner tube banks and through short connecting pipes to the combustion chambers. It is built of eight similar segments, each containing just over 2000 tubes about 4ft long, the total number being 16,500, with a total length of some 12 miles of tube. The shell is fabricated aluminised mild steel fitted with "Yorcalnic" aluminium-bronze tubes, made by the Yorkshire Copper Works, Ltd., $\frac{1}{16}$in outside diameter, 0·020in thick, which are secured to the mild steel tube plates by expanded ferrules. The ferrules are expanded by means of a hydraulically operated riveting gun, which was developed and supplied by Aviation Development, Ltd. The ferrules are threaded on to an expanding mandrel, which is then loaded into the riveting gun. The first ferrule and the mandrel are entered into the tube and, on firing of the gun, the mandrel is drawn back through the ferrule, expanding it and the tube into the tube plate. After expanding, the inside diameter of the ferrule is the same as that of the tube bore. This method of tube assembly, as shown in our diagram (page 613), has been found to be both satisfactory and extremely rapid. The partly assembled unit, as illustrated, clearly shows its construction. To encourage even distribution of the gases along the length of the unit the turbine exhaust tunnel is lined with perforated baffle plates, the resistance to flow increasing towards the rear. This arrangement was felt to be necessary as a result of rig tests which showed there was a tendency for a disproportionate volume of the gases to pass radially outwards only at the rear of the heat exchanger. The design thermal ratio of the heat exchanger is 70 per cent.



Heat Exchanger

Combustion

The machine is provided with a multi-chamber combustion system consisting of eight chambers disposed symmetrically about the axial centre line of the turbine shaft.

These chambers were designed and made by Joseph Lucas, Ltd., and they are based closely on aircraft practice. Flame tubes are of Nimonic 75 nickel-chrome alloy, cooled by the secondary air. The burner case and swirl nozzle are also of Nimonic 75. A simple fuel oil system as shown diagrammatically above, is provided, employing Lucas "Simplex" type burners. The quantity of fuel delivered to the combustion chambers is varied by the opening of a throttle valve fitted in the fuel supply pipe to the burners and controlled by the speed governor through an oil relay. A hand-controlled throttle valve is used when starting up.

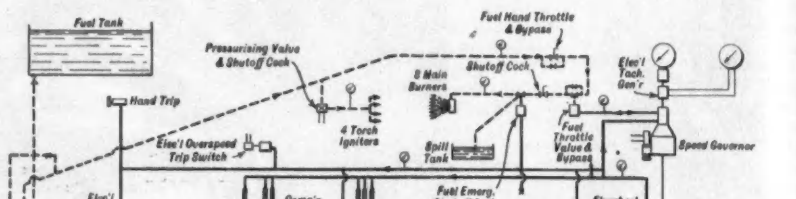
The overspeed shock-proof trip governors, employing unbalanced spring-loaded rings on the compressor and the power turbine shafts, are arranged to operate an emergency shut-off valve in the fuel system by destroying the pressure in the oil relay when the speed exceeds the rated value by a predetermined amount.

Hand trip cocks are fitted both on the machine and on the control panel.

Four of the eight interconnectors fitted between the combustion chambers are fitted with a torch igniter assembly, each assembly consisting of a thermo-couple, a plug and the torch itself. Complete reliability at starting is ensured with this arrangement, as each chamber is ignited directly from a torch. As a double safeguard in the event of one or more of the torches failing to ignite, the interconnectors ensure satisfactory ignition in all the chambers.

The chamber outer air casing is of mild steel sheet, aluminised and fitted with two bellows expansion pieces to take up the differential expansion between the turbine casing and the heat exchanger. Each end of the chamber is secured by a quick-release joint.

Cast stainless steel sections form the 180 deg. inlet bend to the first-stage stator blades. The outer bends, forming half the turn, can be seen bolted to the turbine casing in our illustration on page 613. The inner bend is carried from a ring casting secured to the turbine casing. These bends butt upon a short intermediate section. The bends are lined with Nimonic 75 sheet, there being a joint in the region of the intermediate ring. A cooling air stream is maintained between these liners and the steel bends.



Fuel and Governor Oil System

(To be continued)

Post-Graduate Scholarships in Science

The Royal Society Empire Scientific Conference and the British Commonwealth Scientific Official Conference in 1946 recommended the preparation of a list of post-graduate scholarships available for scientific study within the Commonwealth. The task of compiling such a list was assigned to the British Commonwealth of Nations Scientific Liaison Offices in London. When the British Commonwealth Scientific Office in London was opened in 1948 consideration was given to implementing the recommendation which had been made. Through the generous co-operation of universities, institutions and Government departments throughout the Commonwealth the publication "Inter-Commonwealth Post-Graduate Scholarships in Science" has now been completed. The main objective of the list is to encourage the movement of scientists within the Commonwealth, and only those awards open to members of at least one Commonwealth country or Colony other than the awarding one have been included. The entries are set out in tabular form showing, in addition to the names of the scholarships and the agencies awarding them, details of the fields of study, where tenable, duration and value, closing dates for applications and the addresses to which they should be sent. There are more more than 350 separate entries in the list, and many of them cover a number of scholarships. The list is therefore a valuable work of reference for students and educational authorities. It is published by His Majesty's Stationery Office, price 5s.

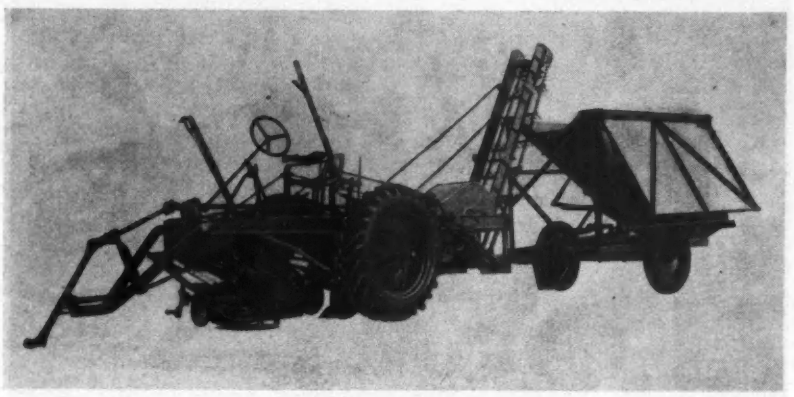
Sugar Beet Harvesting Machinery

THE cultivation of sugar beet is a task which now occupies a prominent place in British agriculture. About 50,000 of the farms of this country include sugar beet as one of their regular crops and each year that has passed since the introduction of sugar beet has added experience in the business of drilling, development of the plant and harvesting and utilisation of the crop.

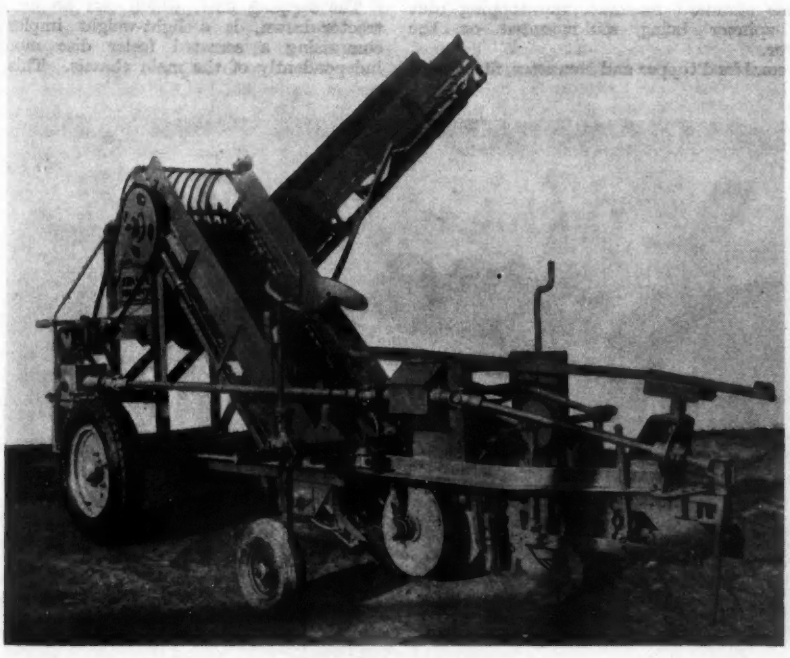
The first successful attempt to produce sugar from beet was made by a German chemist over 200 years ago, though it was not until 1801 that the first factory for the extraction of sugar from beet was built (in Silesia). France, in the time of Napoleon I, started to grow sugar beet and in due time cultivation extended to other European countries and to Canada and the U.S.A. Round about 1832 various attempts were made to establish a beet sugar industry in this country, but the projects then set on foot were not successful. It was not until 1912 that the first modern beet sugar factory was erected here. That factory was built at Cantley, Norfolk, by Dutch interests, but it operated at a loss, the operating company was wound up and the factory was acquired by the English Beet Sugar Corporation, Ltd. It was reopened in 1920 and during the following ten years or so several more factories were built and put into operation in Great Britain. To-day there are eighteen such factories, one of them being situated in Scotland. They are run by the British Sugar Corporation, Ltd., an organisation which came into being by reason of the Sugar Industry (Reorganisation) Act, which was passed in May, 1936. The Corporation's profits are limited, its directors are subject to Treasury approval, and the chairman and at least two other directors are appointed by the Government.

The years between the wars saw a continual increase in the amount of sugar beet grown in this country and increased interest on the part of farmers. But the shortages brought about by the second world war and those that have continued in the succeeding years, have unquestionably led to sugar beet production and treatment becoming a matter of the first importance. The greater part of the beet crop comes from East Anglia, Lincolnshire, the Cambridgeshire Fens and the East Midlands, although considerable acreages are now to be found in Yorkshire and Scotland. A growers' advisory service is attached to each of the eighteen beet sugar factories and the experts engaged in this service keep in close touch with all the farmers who sign contracts for beet growing. Many problems related to seeding, plant development, harvesting and the best use of beet tops have thus been solved. The aim of the sugar beet grower is to obtain a fairly dense, evenly spaced plant population all over his field, with just sufficient room between the rows for the wheels of a tractor pulling cultivating or harvesting implements. It has been suggested that a "plant population" of about 30,000 per acre is normal and, as 410,000 acres of land in this country were given up to last year's crop, it will be quickly appreciated that the business of harvesting and transporting the beet to the factories was indeed a major operation. It may be added that last year's crop was a record one, the total amount of sugar produced being 700,000 tons, or 200,000 tons more than in the preceding year. That quantity of sugar came from 5,216,092 tons of beet, which represented an average yield of 12·81 tons an acre—the highest so far attained in this country.

Beet harvesting, like most farming jobs, has to be carried out in a comparatively short time in order to obtain the best results. The factory "campaign," as it is commonly called, usually extends from about the beginning of October to the end of January, during which time it is essential, of course, that there should be a regular flow of beet to the factories. The crop cannot be stored, so that harvesting has to be done in about three months of late autumn and winter weather. Until recently it was essentially a hand operation, requiring a very large labour force, as the beets must be topped and cleaned. Since the war, however, steady progress has been made in the mechanisation of beet harvesting and each year a greater proportion of the crop has been topped, lifted and cleaned by machines designed and developed for the purpose. In the development of this machinery British engineers have shown their determination and ingenuity. Their products now undoubtedly compare very favourably indeed with the machines of American and Continental origin, which have also been brought into use in this country. In their efforts to provide satisfactory mechanical harvesters, engineers have been faced with many problems. The matter of topping, that is, removing the leaves and the crown, without damaging the beet is one of them; removing the dirt without damaging the beet is another and, as the machines to be of service must work often in the worst possible weather, the question of mud, stones and trash has had to be studied very carefully. A great deal of experimental and development work has been done by the National Institute of Agricultural Engineering, and engineers have also benefited by the co-operation of the British Sugar Corporation and of farmers, who have been anxious to find a way to deal efficiently, economically and speedily with their beet crops. Some indication of the progress made is given by the fact that whereas in 1946 only 0·9 per cent of the British beet crop was completely harvested mechanically, by last year the figure had risen to 13·7 per cent. It seems likely that when the present season's harvest is completed about 20 per cent of the crop will have been dealt with mechanically. During last year's campaign it should be noted, 2120 harvesting machines were at work.



CATCHPOLE TOPPER AND HARVESTER



SALMON COMBINE HARVESTER

To give engineers and farmers an opportunity of seeing the progress being made in mechanical beet harvesting, the British Sugar Corporation, Ltd., in conjunction with the National Agricultural Advisory Services, organises an annual demonstration of British and foreign harvesting machines and ancillary equipment, such as loaders, trucks and silage plant. This year's demonstration was held on the farms of Mr. A. E. Singleton and Mr. J. B. Lees, at Oxton, Nottinghamshire, on October 18th and 19th and was attended by many interested visitors from this country and from overseas. The harvesting machines shown at work were divided into two classes, the first including eighteen machines now in regular production and use, and the second including seven machines still in the prototype and development stages.

In what follows we describe a few of the machines which took part in the demonstration.

One of the machines illustrated herewith is a combine harvester manufactured by John Salmon Engineering Company, Ltd., Dunmow, Essex. Mr. John Salmon, the founder of the company, has had a long experience as a farmer in Essex and also as an agricultural machinery contractor, and the design of his beet-harvester shows that the user's problems have been carefully studied. The machine, which can be driven by the power take-off of any medium-powered tractor, consists of a topper, lifter, cleaning elevator and a rear elevator for loading the harvested beets into a trailer. The topper comprises a vertical multiple-serrated disc feeler wheel, which rides over the tops of the beets and forces them on to an inclined knife. Immediately behind this topping unit there is a set of eight rubber "flippers"—rotating at high speed—the action of which is to clear the severed tops away from the path of the lifter. Twin-armed steel lifting shares raise the beets from the ground to the cleaning elevator. The trough of the elevator is made up of undulating rods, set at an angle to the base, and the elevator flights pick up the beets and carry them over the rods. We noted that the beets passed over the crests of these rods quite successfully without damage and that the soil picked up with them, being of weaker structure, broke up and fell through the elevator slats. As the beets pass over the elevator they are, of course, continuously shaken and much of the soil is removed from them. The cleaning elevator delivers the beets into a rear hopper, whence they pass to the rear elevator. Heavy-duty, wide-link malleable chains are employed for the main elevator and chains of rather lighter section for the rear elevator. One of the claims made by the makers of this machine is that its steering unit gives precise control while working and allows the tractor to turn at an acute angle to the harvester at headlands. This movement is obtained by a steering-bar actuating in a rack attached to the tractor. It can be conveniently adjusted or disengaged by the operator and enables the harvester to be turned on a 6-yard headland and set in squarely to the first beet in the row. The main frame of the machine is of angle steel and is mounted on pneumatic-tyred wheels. A final point is simplicity of operation; there are only two controls, the one being the power lift on the tractor for raising the machine out of the ground and the other the steering.

The second complete beet harvester, which we illustrate, is that built by the Catchpole Engineering Company, Ltd., Stanton, Bury St. Edmunds. This machine also is driven by the power take-off of a tractor, the drive being taken through a conventional, universally-jointed shaft to two separate gearboxes. One of them is situated at the front of the machine and drives the topper and spinner units; the other is placed at the rear and takes the drive to the elevator and delivery conveyor. Connection between the rear gearbox and the main power shaft is made by a flexible chain coupling, which prevents the drive being strained by any flexing of the main frame. The topping is done by rotating twin discs, which are spring-loaded to prevent blockage by stones. The discs are carried on a track unit, which travels along the top of the crop and ensures that the discs cut an equal depth of crown from each beet. Behind the topper there is a spinner, the function of which is to clear to one side the leaves and tops severed by the discs. The digger and elevator incorporate heat-treated steel lifting shares, carried on arms which are adjustable for pitch and depth. The furrow slice from the digging shares is received between an upper and lower rod link elevator, the beets being gripped between the flexible upper and lower elevators, and are thus moved along to the knockers, by which they are cleaned and passed to a side delivery conveyor. The standard machine can now be fitted with a rear elevator and trailer into which the harvested crop is loaded. The firm has also introduced recently a fully-mounted harvester, known as the Catchpole "Minor," which took part in the demonstration. It is constructed on the same principle as the standard machine, the topping unit and spinner being mid-mounted on the tractor.

A combined topper and harvester, fitted with a rotary lattice drum, which separates the beets and the soil, is the "Robot" manufactured by Transplanters (Robot), Ltd., Sandridge, near St. Albans, Herts. This is another machine which is driven by the power take-off of a tractor and which includes a topping unit, similar to those employed on the harvesters described above. A feeler wheel guides the beet tops to the rotary knife and a revolving flail, mounted just behind the knife, clears the tops. The cutting depth of the knife can be pre-set and, if the beet tops vary in size and a different topper weight is needed, adjustment can be made by controlling the total weight of the topping unit. A spring-loading device can be used to increase the weight in approximately half-pound stages. Adjustable shares lift the beets and a specially designed spider breaks the soil from them as they are delivered to the rotating drum. The drum, of course, sifts the remaining soil from the beets and passes them on to a side elevator, which can load them into a trailer running alongside.

ROBOT COMBINE HARVESTER

At the demonstration there were in operation some machines which remove the tops of the beets and which are then followed by lifters and loaders. The "Roerslev" equipment is in this category and one of our illustrations is of a lifter and elevator now built in this country by Johnston Brothers (Contractors), Ltd., Ibex House, Minories, London, E.C.3. The design of this machine and of the topper, which was also at work, is based on Danish patents. The "Roerslev" lifter is another example of a beet harvester, in which complicated mechanism has been avoided. The machine illustrated is tractor-drawn and powered and consists of a two-pronged lifting fork, a cylindrical cage and a side delivery elevator. The fork is arranged so that its depth and penetration into the ground can be adjusted by a hand lever, to suit either the size of the crop or the nature of the soil. A disc coulter guides the lifted beets to the cage, which revolves on an axis at right-angles to the direction of travel and which gently agitates the crop to remove dirt. Four guide vanes are evenly spaced round the circumference of the cage and the beets are directed to the hopper of the elevator and discharged. The final drive to the elevator is taken through spur and bevel gearing and is fully enclosed, and double elevator chains have been fitted. The two land wheels, fitted at the rear of the machine, restrain the drum from lowering itself into the soil when heavy going is encountered. They have smooth steel treads 4in wide and can be adjusted vertically to meet any special operating conditions.

The topping unit, which can be horse or tractor-drawn, is a light-weight implement, comprising a serrated feeler disc mounted independently of the main chassis. This disc

ROERSLEV LIFTER AND ELEVATOR

is chain-driven from the land wheel. Below the feeler disc and mounted on the same independent chassis is the topping knife. The action of the machine is that, as the feeler disc rides over the centre of each beet it moves the topping knife up and down as it rises and falls. A disc coulter is fitted at the front of the implement to cut through long weed growth. It may be added that "Roerslev" toppers are now being produced as one or two-row units.

Within the scope of this article we have not attempted to describe all the machines which took part in this year's beet harvesting demonstration. Those that have been mentioned are a representative selection, all of which deal with one row of a crop at a time. Progress is now being made with both toppers and lifters which will handle more than one row. It may seem that engineers still have much to accomplish before full mechanisation of sugar beet harvesting is achieved but this year's demonstration, like its predecessors, emphasised the satisfactory developments which are taking place.

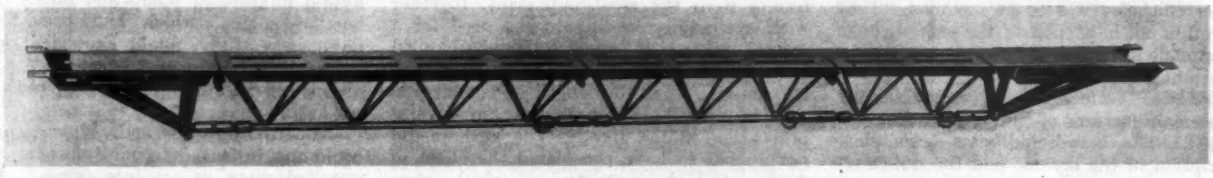
Falsework Units for Reinforced Concrete Construction

THE accompanying illustrations show examples of a system of lattice braced shuttering units which has recently been introduced into this country from Germany by Blaw Knox, Ltd., 94, Brompton Road, London, S.W.3, and is known as "Hico" centering. Our first illustration shows a typical falsework beam made up of these units, and consisting, in this case, of three elements of different length and two bearing units, one at each end. The joints between the units are made with clamps in the top chord of the beam, and turnbuckles in the lower one. By tightening the turnbuckles an initial prestress is induced in the beam, which thus arches upwards slightly, the deflection being adjusted so that when the wet concrete is placed, the beam will be perfectly flat. For striking this shuttering, one of the turnbuckles is provided with a swivel joint. By pulling out the peg fastening the two sections together and by taking out a bolt holding the upper part, the beam will divide into two parts and can be dismantled easily.

The lattice units have been designed so that each one is light enough to be handled by one man, and so that a beam of any length can be made up between 1 and about 9 yards. The weight of the beam is about 25 lb per lineal yard. Each unit consists of a light pressed channel section for the top boom with a bearing width of 6in, the lattice frame being formed of round steel bars welded together and on to the top boom. These units are made in lengths of 24¼in, 37in and 49¼in. The end bearers are in two sizes, which are adjustable between lengths of 19¼in and 25¼in, and 24¼in and 33¼in respectively, and end bearers of 8in width may also be employed in special cases. Adjustable angle iron cross members may be used between adjacent beams; they are in two sizes, with lengths adjustable between 3ft 3¼in and 5ft 4in, and 4ft 7in and 5ft 4in respectively. Other ancillary units include equipment for supporting shuttering round a steel joist at the beam ends, and claws for carrying the end bearers below the level of the bottom flange of a steel joist.

This method of shuttering has been the subject of extensive tests at the School of Engineering of the Hanover Institute of Technology, and the weight of slabs that can be carried for various spans and distances between the centering beams has been determined. The calculations include an allowance for live load of 30·8 lb per square foot, and have been drawn up in tabular form. According to these tests, the permissible bending moment to which the "Hico" unit may be subjected is 38·8 inch-tons and the permissible bearing load on a standard bearing end is 0·985 ton. As an example from the loading table mentioned above, the permissible free span is 20·2ft for a load of 49·2 lb per square foot, and a spacing between the centering beams of 24·6in. Similarly, for a load of 102·5 lb per square foot, the permissible free span is 17·6ft when the centering beam spacing is 19·7in, and is 6·6ft when they are 59in apart. The permissible spans may be exceeded by the use of props at the end junctions of the units.

Tables may also be used for computing the deflection which it is required to induce with the turnbuckles, under any given loading conditions, and for instructions for combining the units to form beams of any given span between 39in and 26ft 11in. The makers point out that should an incorrect initial deflection be given to the shuttering, adjustment can be made on the turnbuckles to ensure a flat soffit whilst the concrete is still green.



13FT SPAN FALSEWORK BEAM

BEAMS FOR CONSTRUCTION OF A FLOOR SLAB

ADAPTATION FOR ARCH CONSTRUCTION

Atomic Energy Commission's Isotope Exports

THE U.S. Atomic Energy Commission recently enlarged its radio-isotope export programme to include all radio-active materials now being sold in the United States on an unrestricted basis. This action increases the number of American isotopes available to buyers in foreign countries from twenty-six to ninety-nine. Among the more useful of the newly available isotopes are cesium-137, ytrium-91, selenium-75 and tantalum-182, which all have applications in industrial research; chromium-51, nickel-59 and 63, and tungsten-185, which are useful in metallurgical research, and rubidium-86, which is an important substitute for the shorter-lived sodium-24 and potassium-42 in agricultural research. American manufacturers now are also permitted to export radio-active thickness gauges. The American isotope export programme has been in effect since September 3, 1947. To date, more than 1000 shipments of isotopes have been made to foreign nations, and the largest users have been Australia, Belgium, Denmark, Sweden and the United Kingdom. The isotopes most in demand in foreign countries have been phosphorus-32, iodine-131 and carbon-14. The revised isotope programme also permits the Oak Ridge National Laboratory, which produces most American radio-isotopes, to provide special irradiation services to scientists of other nations. Under this provision, foreign scientists may send special materials to Oak Ridge for irradiation. The only isotope, which is distributed within the United States on a limited basis, but is not available for export, is hydrogen-3.

The Institution of Mechanical Engineers

AT a general meeting, held at the Institution of Mechanical Engineers, last Friday, November 9, 1951, the following paper was presented and discussed :—"The Design of Large Pumping Installations for Low and Medium Heads," by G. A. Wauchope, M.I.Mech.E., and H. P. Humphreys, B.Sc. (Eng.), A.M.I.Mech.E.

An abstract of this paper is printed on page 622.

The following discussion took place.

Discussion

Mr. H. R. Lupton said that the lesson which more than any other should be learned from the paper was the very great importance of the user of pumping machinery first finding out what he was likely to want to do himself and then communicating to the manufacturer of the pumps exactly what he wanted. Over and over again inquiries were sent out which stipulated that the pumps were to be of a certain size, often with a certain arrangement and to do a certain duty, and there would be a penalty on their performance if they did not do that duty exactly; but there was an entire omission of the range of duties required for the purpose. The paper made it very clear that, not just one duty, but the whole story must have full consideration if a plant giving the proper efficiency was to be installed. That had often not happened in the past, and the paper made it very clear that that was a most important thing.

There were various ways of communicating to the manufacturer of the pumps what was wanted. The user could give a complete description of the lay-out and the duties required, or he could do some of that work himself—which, of course, he ought to do as the user of the pumping plant. Many users said that they did not know just what the pumps were going to do. In that case, certainly the manufacturer could not know, and the user had got to make the best estimate that he could. Among other things which the authors had examined was the question of the type of electric motor which would generally be the best for a particular job. He had been amazed at times to find how rarely in the waterworks field any motor other than an induction motor would compete. Nearly always he had found in waterworks practice that commutator variable-speed motors—and still more rectifiers and d.c. motors—would not, taking the whole survey of the duties over a whole year, compete with an ordinary induction motor, if necessary, with rotor resistance control. Of course, in saying that one must never forget that the average was weighted in accordance with the number of hours required for each duty, but it was weighted also in that the lower speeds, in which the efficiency of the induction motor was lower, absorbed less horsepower when they were running than the pumps did at the higher speeds, so that there was a double weighting in favour of a motor the efficiency of which fell off with reduction in speed. He had generally found that the higher peak efficiency of induction motors nearly always made them compete favourably, in spite of the waste of rotor control, with other motors. A point which the authors had not mentioned was the problem of starting torque. Particularly if one wanted to put a squirrel-cage motor on to drive an axial-flow pump, one had to be very careful that the starting torque of the motor would be enough, because an axial-flow pump, starting into range at the full normal delivery head, would probably get up to its full head at somewhere about 60 per cent of the full speed, but the torque which it required to drive it with total water flow at 60 per cent of full speed was in the nature of 80 per cent full-load torque. It was necessary to be careful that the starting characteristics were such that it would start up so as to give as much as 80 per cent torque at 60 per cent speed.

Mr. J. F. Breeze said that the effect of the design of large "rotodynamic" pumping plants upon the cost of buildings and foundations was often of decisive importance, particularly to avoid costly alterations of existing buildings. He remembered in one case choosing 1000 b.h.p. horizontal oil engines with eight cylinders arranged in sets of four *vis à vis* to drive two mixed-flow storm water pumps, each of 300 tons per minute capacity, in preference to vertical engines with eight cylinders in line because the former just fitted into the existing beam engine-house, whereas choice of the latter would have necessitated a good deal of enlargement at a cost in excess of the difference in cost of the two kinds of engine, the other factors being about equal. In the case of public utility services, the long-term results were the most important, together with availability leading to the need for a careful choice of speed. He had good authority, and some grounds from experience, for thinking that the length of commission was in practice approximately in inverse proportion to the speed. The authors did not appear to have considered the effect of fluids of high viscosity or which were corrosive or contained erosive matter, in the design of pumps, and he suggested, there were fruitful fields for research, particularly for pumps in the rotodynamic category, so as to meet satisfactorily the requirements for a variety of industrial processes and also sewage treatment and disposal works. Also, attention should be drawn to the value of the use of models for comparative aerodynamic or hydraulic determination of the design of the types of pumps under consideration, because of the difficulty of correct theoretical calculation of eddy and skin friction losses.

Mr. L. E. Prosser, observing that the authors had drawn attention to the magnitude of the total horsepower of pumping plant installed in this country, emphasised the need, which was particularly urgent in the country's present economic plight, of using all possible means of improving the efficiency and reducing the capital cost. The argument was often used that manufacturers had, over a long period, perfected their designs to such an extent that possible improvements were now only fractional, and that they must be very fully substantiated before risking any appreciable departures from conventional practice. In the past improvements in plant design had been mainly stimulated by the active competition between manufacturers, but under present conditions both the direct financial incentive and the availability of staff for this purpose were at a minimum. It was therefore greatly to the credit of the hydraulic industry that it had formed a co-operative research association, whose staff were free from the day-to-day worries of production and had the necessary facilities to carry out research to complement the development work of the individual member companies. It might be appropriate for him to mention that active research was now proceeding on a number of problems closely related to the kind of plant described in the paper. These included investigations of the flow conditions inside centrifugal pumps and work on cavitation erosion, both of which were fundamental and would, it was hoped, lead to ultimate improvements of marginal efficiency. A second phase of the work was concerned with more definite problems, such as obtaining improved designs of suction sumps to prevent entrainment of air by vortices; the behaviour of gland packings and alternative types of seal; and problems of pressure friction and surges in pipe-lines. There was a third kind of activity, which hardly fell within the province of a research association, but which was now rendered more desirable by the virtual elimination of the individual inventor, and that was to consider the development of quite new methods or revival of discarded ones using new techniques or materials. For example, the paper showed that some of the difficulties in obtaining good overall efficiency in a low head pumping installation arose from the relatively large variation in head due to tidal or other changes in water level. The old-fashioned reciprocators were more flexible in this respect, and it seemed that it might be possible to develop high-speed positive displacement machines of perhaps unorthodox types, whose possibly greater first cost might be offset by higher overall efficiency. Reconsideration of the Humphrey pump, that hybrid mixture of pump and internal combustion engine, which had proved itself quite successfully, might show that it had economic advantages under present conditions of shortage of electric peak load capacity.

Mr. H. Fossett asked, how accurately could one, in fact, determine efficiency of the installed plant in absolute terms? For a particular installation (which he described) the capitalised value of 1 per cent in efficiency was about £5000. They had not been in a position to effect absolute measurements of flow, as, for example, by filling a reservoir. They had had a venturi meter designed to B.S.S. in a 69in main, but it was doubtful whether one could be certain of its absolute accuracy within 1 per cent. So it was believed that chasing efficiency in such a case was rather intangible, and the main emphasis in the decision had been a positive and concrete saving in capital installation.

Mr. J. Peck remarked that one factor not emphasised in the paper was that of starting a pump against a shut valve when driven at constant speed. For example, if axial-flow pumps had been chosen for an application shown in the paper, the power required to start the pumps against the shut valves would have been from 2 to 2·5 times the normal power at normal speed. Hence the advantage of the centrifugal pump for which the horsepower curve remained nearly constant for all discharges. However, when an oil engine drove an axial-flow pump, stalling at shut valve might be avoided by reducing the speed to about 75 to 80 per cent of the normal speed. Would the authors give their opinion concerning the reliability of bevel gearboxes when oil engine drives were used for vertical spindle pumps, as torsional vibrations were liable to cause trouble?

Mr. P. Linton said that his remarks would concern the problem of pressure surges, a question to which the authors had been able to devote but little space. Depending on the length of the pipeline, the authors distinguished three different kinds of problem, the second of which did not usually give rise to dangerous conditions. While the first case

—length short compared with static head—was a somewhat specialised application and depended largely on the type of reflux or control valve installed, the third group included most of the large pumping schemes, where any damage to the pipe-line due to water hammer would have the most serious consequences. The drop in pipe pressures when the supply to the pump motor failed was determined largely by the rate at which the speed of the pump fell. It varied with the moment of inertia of the pump-motor combination and depended also on the characteristics of the pipe-line, since the hydraulic output absorbed some of the stored kinetic energy. As an example, the head of a pump of 840 h.p. might fall from 220ft to the suction pressure in as little as 1·6 seconds. If the pump was discharging into a long line, this time could be considerably shorter than the period $2L/a$ of the pipe, where L=length of pipe, a=surge velocity. Even in medium-head installations very low pressures might be set up in the pipe if the pump slowed down at such a fast rate, in spite of the fact that a bypass was fitted to protect the pump, as suggested by the authors. In a simple system, consisting of a pump discharging into a reservoir through a long line, an interesting feature was the fact that the lowest pressure occurred not at the pump, but at some distance along the pipe, in this case when $t=\frac{3}{4}\frac{2L}{a}$. Depending on the actual static head and on the various gradients along the pipe, it was therefore quite possible that the absolute pressure would fall below the vapour pressure somewhere along the pipe, thus producing cavitation and separation of the water column. The water column did not necessarily break at a change of gradient or at a particularly flat or steep section of the line; the main criterion was the position of the lowest point of the hydraulic gradient which depended essentially on the rate at which the pump decelerated. The difficulties caused by cavitation in a pipe were becoming more and more widely recognised. The water engineer's point of view had been expressed very forcibly during the discussion on a previous paper on water hammer, whose author had suggested that air should be admitted into the pipe to cushion the resulting shock. There was some evidence that the drop in pressure caused not a complete separation of the column, but a type of cavitation similar to that observed in pumps, accompanied by erosion of the pipe walls at the points where the vapour bubbles collapsed. The British Hydromechanics Research Association had just installed an experimental pipe-line containing a transparent section which would allow this problem to be studied in greater detail.

Mr. T. F. Steel said that all the plant components of a pumping installation were interrelated, and therefore it would appear to be wrong in principle to consider the variations in individual plant items without considering the effect of those variations on the remainder of the system. In the case of a thermal power station circulating water system the type of screening plant to be installed would be dictated by the nature of the debris in the circulating water, the variation in level of the water and the relative capital and running costs of the various types of screening plant. It might be considered economic to combine the screen chambers and pump-house into one building and therefore the space available for the pumps might tend to be dictated by the space requirements of the type of screening plant adopted. With regard to the calculations required to determine characteristics of power station circulating water pumps, it was stated: "An important decision is the most economical means of keeping the pump discharge approximately constant with varying head, and having obtained the head variation with maximum and minimum tide from the above calculations, the most suitable type of speed control must be considered." Was not the important decision one of deriving the most economical and reliable means of operating the power station? It could be demonstrated that the additional water delivered by constant-speed pumps, when operating against low heads, resulted in improved vacuum, and if the turbine and condensing plant were suitably designed the improved performance of the turbine due to the improved vacuum should outweigh any saving in pumping power. Where a number of constant-speed pumps were arranged in parallel and interconnected on the discharge side, as they should be, and conditions necessitated a reduction in water quantity, e.g., when cold water was available, the simplest and cheapest method of doing this was to reduce the number of pumps operating. It would be appreciated that the number of pumps installed dictated the degree of regulation which could be obtained with constant-speed pumps. Generally, there did not appear to be any justification for variable-speed circulating water pumps on a modern power station.

Opening of Heavy Forge at Sheffield

THE new heavy forge which has been built at the East Hecla Works, Sheffield, of Hadfields, Ltd., was formally opened on Thursday of last week by H.R.H. The Duke of Gloucester, K.G. This plant, which was fully described in our last issue, has been designed to handle ingots up to 45 tons in weight and to produce forgings up to 40in diameter or up to 40ft long; it will produce rings up to 12ft diameter and sleeves up to 6ft diameter and 10ft long. The forge building is situated near to the steel-making plant and occupies 122,000 square feet.

At a luncheon prior to the opening ceremony, a welcome to H.R.H. The Duke of Gloucester was expressed by the chairman of Hadfields, Ltd., Lord Dudley Gordon. He recalled that the position which the firm had now occupied for many years was the result of the genius of the late Sir Robert Hadfield, who, at the age of twenty-nine, had inherited the steelfounding business which his father had started in 1872 at the Hecla works. Sir Robert devoted his talents as a scientist and administrator to improving and extending the business which bore his name. He was one of the pioneers who did so much to develop the British steel industry and to make it the most efficient in the world. It was typical, Lord Dudley Gordon continued, of Sir Robert's courage and foresight and of the prevailing spirit of free enterprise that when the Hecla works, then covering 4 acres, could be no further extended, there was acquired, in addition, the site of the East Hecla works. It was a bold move, Lord Dudley suggested, to acquire a site of well over 100 acres, which was probably the largest single factory area in Sheffield without intersecting public roads, and to build on it the works which now covered the site.

Lord Dudley went on to say that during three wars those works had made an important contribution to the armaments which were necessary to secure victory, and that many of the buildings had been erected and equipped as emergency measures to provide some urgently needed war store. At the end of the last war in 1945, a heavy programme of deferred repairs had to be put in hand, and it was also necessary to reorganise and provide new equipment for nearly every department in the works. Lord Dudley explained that amongst the projects with which it was then decided to proceed was the improvement of the forging facilities. At that time the forging facilities consisted of a heavy forge, equipped with steam-driven presses, which had been constructed as a wartime measure during the first world war, in a position remote from the steel melting plant. The construction of a completely new heavy forge in a more convenient position and adjoining it a light forge equipped with a number of modern air hammers was the only possible solution of the problem. Buildings covering an area of over 100,000 square feet, which had been used during the last war for the production of armour plating for aircraft and tanks, had been completely demolished and in their place there had arisen the new forge which had cost more than £1,250,000. It was a fortunate coincidence, Lord Dudley concluded, that though the construction of the forge was decided upon and designed for commercial work, it had come into operation when it could make an important contribution to the extensive rearmament programme on which the country had embarked.

In the course of a speech at the luncheon, the Duke of Gloucester congratulated the firm on an outstanding contribution not only to the nation's essential armaments in two world wars, but also to its peacetime industrial and commercial development. His Royal Highness paid tribute to the work of the late Sir Robert Hadfield during fifty-five years in the service of the steel industry. The steel industry, the Duke said, was particularly important to the nation at present, and he expressed his best wishes for the continued success of Hadfields, Ltd.

Thanks to the Duke of Gloucester, and greetings to the many overseas guests who attended the ceremony, were expressed by Mr. H. Humphries, deputy chairman and managing director of the company.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

SCREWING TAPS

No. 949 : 1951. The revision of this specification was originally proposed in order to include tables of general dimensions for taps for special fine-pitch threads, threads in certain American and metric series, and other threads in common use. It was subsequently decided that some amendment to the tolerances on the threads was also desirable, and with the publication of B.S. 1580 on unified threads it was felt that an endeavour should be made to formulate tolerances which would be applicable to unified threads as well as to those covered by the previous standard.

The standard has been considerably enlarged and, in addition to a number of extra tables of general dimensions and tables of limits of size and tolerances of taps for the recognised British Standard thread series, including unified screw threads, information is also given to enable limits and tolerances of taps for special threads and for intermediate normal sizes not included in the standard, to be readily calculated. Price 15s., post free.

HYDRO-EXTRACTORS AND CENTRIFUGAL MACHINES

No. 767 : 1951. This is a revision of the specification "Hydro-extractors," originally published in 1938, and the alteration in the title has been made in order to avoid confusion.

In it, the method of calculating the stresses in the basket shell and hoops has been simplified as far as possible, and allowable stresses for the constructional materials have been brought into line with current practice.

The standard in its revised form covers hydro-extractors and centrifugal machines having vertical, horizontal or inclined shafts, running at speeds from 400 to 3000 r.p.m., for use in laundries, textile and other trades. It sets down certain principles governing the design, construction and operation of hydro-extractors and centrifugal machines used for the extraction of liquids from solids, but it does not apply to high-speed centrifuges or separators used, for example, in oil or cream separation plant.

The standard covers such matters as details of basket construction, quality of materials, safety designs, tests and marking. In the appendices it gives information on operation and maintenance, as well as detailing information to be supplied with the inquiry or order. Price 2s. 6d., post free.

The Works of the Steel Company of Wales

No. III—(*Continued from page 583, November 9th*)

The Power Plant

BEFORE leaving the reconstruction of the Margam section of the works to deal with the new Abbey works, it is of interest to note that an integral part of the scheme is the rebuilding and re-equipment of the original steam and power plant station at Margam. This work is being done in stages designed to maintain existing services without interruption. Under the plans laid down the boiler-house and the turbo-generator room are being housed in a single building, one end of which can be seen in Fig. 12.

The boiler plant extensions are designed to replace gradually the existing plant, consisting of low-pressure boilers, turbo-generators and turbo-blowers, by high-pressure plant operating at much higher efficiencies. The new main boiler installation consists of four water-tube boilers supplied by Simon Carves, Ltd., with provision for a fifth to be installed at some future date. These boilers are designed to burn a total of 5,400,000 cubic feet of surplus blast-furnace gas per hour and the steam is used to drive the new turbo-blowers and the new turbo-generators. When the blast-furnace gas supply is capable of producing more steam than is required for the electrical load for the rest of the plant, any surplus electricity is "exported" to the British Electricity Authority.

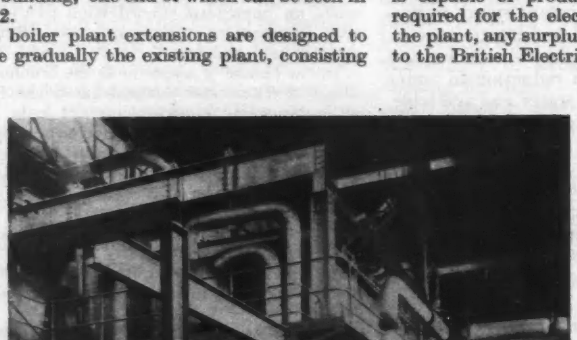


Fig. 11—Power Station Boilers

The new boilers, the first three of which are illustrated in Fig. 11, are of Simon Carves tri-drum, twin-flow, cold-feed design. They operate at a steam pressure of 625 lb per square inch superheated to 820 deg. Fah. with each boiler burning 1,350,000 cubic feet of blast-furnace gas per hour, the gas having a calorific value of 92 B.Th.U. per cubic foot. The guaranteed efficiency of the boilers is 84·5 per cent and the maximum continuous rating of each boiler is 87,200 lb per hour. The coke oven gas used has a calorific value of 500 B.Th.U. per cubic foot, while the oil fuel has a calorific value of 18,000 B.Th.U. per pound.

Four multi-jet gas burners fitted to each boiler, are situated immediately below the combined oil and coke oven gas burners, in the lower front wall of the combustion chamber. The volume of each combustion chamber is 5560 cubic feet, and it has water cooling on the two side walls and on the front wall above the burners. This radiant heating surface is fed with a supply of water independently of the tri-drum section of downcomers from the main steam drum.

Horizontal "MeLeSco" superheaters are installed, and they consist of forty-four tubes, each 139ft long, giving a total heating surface of 2800 square feet. These superheaters are supported within the boiler on steam-cooled tubes which form the steam inlet to the superheater.

Economisers of the steaming type are fitted and they have unrestricted feed to the main steam drum. These economisers have a total heating surface of 11,845 square feet, and raise the temperature of the feed water from 250 deg. to 446 deg. Fah. The Howden tubular air heaters installed have a total heating surface of 12,800 square feet, and they increase the air temperature from 80 deg. Fah. at the inlet to 340 deg. Fah. at the outlet.

Fig. 13—500,000-Gallon Water Tower

Fig. 12—Power Station at Margam Works

As the boilers have been designed primarily to burn all the surplus blast-furnace gas, automatic boiler control is provided only when burning this gas—combustion control is manual when coke oven gas or oil in addition to blast-furnace gas is in use. The automatic control for blast-furnace gas and air for each boiler consists of a gas flow/air flow meter which is coupled through a power cylinder and rheostat to a variable-speed motor driving the forced draught fan. The gas flow/air flow meter transmits its impulses to the power cylinder, which, in turn, operates the rheostat on the boiler control panel. The blast-furnace gas supply is variable and any variation through the control is automatically followed by a variation in the air supply to maintain a constant air-fuel ratio at the burners. The ratio is adjustable manually by individual valves so that it can be correctly set before the automatic control takes over.

Should the quantity of blast-furnace gas fall below the point where a reasonable pressure across the burners is available for control, two of the four burners cut out in sequence automatically. When the quantity of gas available increases the two valves reopen. To maintain correct conditions in the combus-

tion chamber, the induced draught fans are driven by variable-speed motors, which are controlled by the pressure in the combustion chamber below the superheater.

The generating equipment which has been supplied by the General Electric Company, Ltd., consists of two 8000kW, 11kV, mixed-pressure turbo-alternators and a 2025kW, 3·3kV pass-out, back-pressure set. The two larger units are arranged to run in parallel with each other and with the grid, whilst the smaller set is designed for parallel operation with an existing set of the same rating. Two alternative supplies of high-pressure steam are available—600 lb per square inch at 800 deg. Fah. from the main boilers already described, and a 300 lb per square inch at 700 deg. Fah. which is to be supplied from a battery of waste heat boilers being installed at the furnaces in the adjoining Abbey Works.

The mixed-pressure turbo-alternator sets operate from the high-pressure steam supply and a low-pressure supply from the exhaust flow from the blower turbines, the control gear being so arranged that, when available, low-pressure steam is used in preference to the high pressure. The 300 lb per square inch steam main supplies the double pass-out, back-pressure turbine. The primary pass-out from this set provides 165 lb per square inch process steam for use in the works and the secondary pass-out supplies steam at 30 lb per square inch for boiler feed water heating.

Air for the blast-furnace is supplied from the three turbo-blowers in the power-house. Each of these units is driven by a back-pressure turbine supplied with steam at 600 lb per square inch gauge at 800 deg. Fah. and exhausting at 15 lb per square inch absolute. One of these blowers is designed to deliver 60,000 cubic feet per minute of free air against a pressure of 18 lb per square inch gauge, the power required being 4939 b.h.p. at 2850 r.p.m. Reavell-Askania regulators are fitted on the machines to give constant-volume air delivery and to prevent surging.

The two other turbo-blowers are generally similar, the turbines operating under identical steam conditions. When operating at maximum capacity each delivers 80,000 cubic feet per minute of free air against a pressure of 18 lb per square inch, and the power required in each case is 6580 b.h.p. at 2600 r.p.m.

A prominent part of the equipment at Margam is the reinforced concrete water tower built by Simon-Carves, Ltd. This tower, which is one of the largest in the country, has a capacity of 500,000 gallons, its overall height from ground level being 130ft.

Its tank is in two annular compartments, an inner one 42ft 6in diameter and an outer one 65ft diameter, the maximum depth of water being 31ft. The tank is supported on a cylindrical tower of the same diameter as the inner compartment, and also on an internal shaft 8ft square. The upper portion of the shaft houses a spiral staircase which gives access to the top of the tower and to the tanks. The lower portion of the tower houses the valves serving the 36in diameter feed and delivery pipes. It is of interest to note that the whole of the supporting structure—that is, the 42ft 6in diameter tower and the internal square shaft up to the level of the beams supporting the water tank bottom—was constructed with continuously moving forms. Work on it was carried out continuously day and night, and concreting was completed in ten days, an average rate of progress of 9ft 6in every twenty-four hours. No external scaffolding was used to support the shuttering for the water tank conical bottom and walls, which project 10ft beyond the face of the tower itself. The shuttering was supported on forty inclined radial profiles which were bracketed out from a ring beam at the tank bottom level.

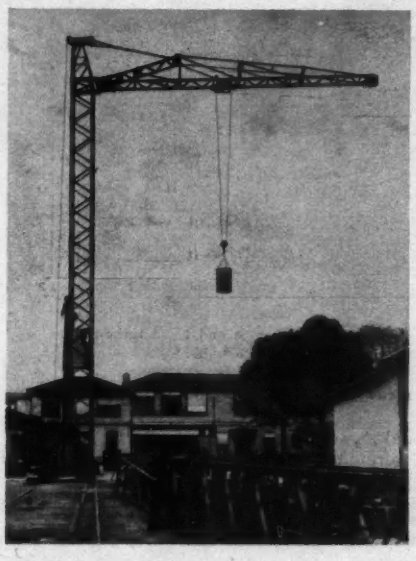
(To be continued)

THE CORROSION OF BURIED METALS.—The Iron and Steel Institute states that the symposium on "The Corrosion of Buried Metals," arranged for Wednesday, December 12th, will be held at the Institution of Electrical Engineers, Savoy Place, London, W.C.2. It will begin at 10 a.m.

Tower Cranes for Building Work

Tower cranes for use in building and light constructional work, made by Jules Weitz, of 111, rue des Culattes, Lyon, France, which have been widely used on the Continent for some years, are now being supplied in this country by Machinery (Continental), Ltd., 175, Brompton Road, London, S.W.3. From the range of cranes available we have selected for purposes of description the "G 12," illustrated below, as a typical unit, which incorporates most of the design features of the other models.

This particular crane is mounted on a truck running on a 7ft gauge rail track and has all its movements directly driven by electric motors. It has a rigid lattice steelwork tower, which is normally erected with two 22ft long intermediate sections, but if the full height is not called for only one of these sections may be used. A jib at the top of the tower is also



TOWER CRANE

built in two sections for ease in erecting on site, and it can be arranged as either an operating unit, or as a fixed unit set at right-angles to the tower and carrying a travelling trolley, from which the load is suspended.

With the jib arranged as a fixed unit and using the trolley, loads of up to 1685 lb can be handled at 52ft 6in radius and up to 5511 lb at 19ft 8in radius. the height under the hook being 65ft 7in. With the jib as an operating unit loads of up to 1874 lb can be handled at 52ft 6in radius and raised 82ft, or loads up to 5511 lb at 24ft 8in radius can be raised to 112ft.

The makers state that the crane is stable without the use of jacks or stays and can travel under loaded conditions under a wind force of 47 m.p.h. It has to be anchored when winds of over 74 m.p.h. are blowing.

The heavy fabricated and riveted steel section undercarriage of the machine runs on double-flanged rail wheels, two of which are driven through reduction gearing by a 3·5 h.p. motor. The travelling speed is about 100ft per minute and wedge brake gear is provided to hold the carriage when in the working position. The crane rotates on a heavy steel pivot on the undercarriage, the tower being mounted on one side of the base frame of the superstructure and a ballast box on the other side. Fitted to the top of the pivot is a foot-step bearing with a gunmetal bush and this bearing is carried on a central thrust ring with a spherical seating. The arrangement is such that the slewing mechanism will not bind on the pivot should the rails carrying the crane be laid unevenly. Four cast steel wheels running on bronze bearings guide the slewing unit on the undercarriage. The crane is slewed at 1·1 r.p.m. by a 2 h.p. motor through reduction gearing and a flexible coupling.

The hoisting winch of the crane is also mounted on the superstructure frame, and is driven through gearing and a 6·5 h.p. flange-mounted motor to give two hoisting speeds of 74ft per minute for loads up to 2200 lb, or 30ft per minute for loads up to 5511 lb. An automatic electro-magnetic brake comes into effect to hold the winch when the hoisting motor is not operating.

The travelling trolley on the jib runs on the lower girder members and is mounted on four wheels. Its position on the jib is adjusted through two cables controlled from a small winch, which is driven by a 1 h.p. motor, and situated at the foot of the jib, near its connection to the tower. Two return pulleys for the lifting cables are mounted on the trolley and an overload mechanism on the trolley prevents excessive weights being lifted at any given radius.

A point of particular interest in this crane and other, lighter models of the same design, is the arrangement of the operator's cabin within the framework of the tower. This cabin can be elevated or lowered to give the driver the best possible view of the load at all times. As the complete tower and jib assemblies rotate as a single unit, the driver is always facing in the direction of the load.

The crane is operated through four handles on the cabin control desk, one each for lifting and lowering, for longitudinal travel in each direction, slewing in each direction and trolley travel on the jib. Changing over from a fixed to a working jib can be carried out without dismantling the trolley or the jib. When using a working jib its angle is varied by means of the lifting hoist, with the use of an automatic locking device operated from the cab. When installing a crane on site no outside lifting tackle is required as all the units are designed to facilitate self-erection.

We were recently invited to a demonstration of various tower cranes, which are being studied by the Building Operations Research Unit of the D.S.I.R. A crane similar to the ones mentioned in this article was seen at the site of the construction of some blocks of flats at Denmark Hill for the Camberwell Borough Council, the contractors being Wates, Ltd. The cranes seen at the Thatched Barn Experimental Station of the D.S.I.R. were smaller experimental models intended for use in the construction of smaller buildings, such as houses.

Technical Reports

Relaxation Spectrum for Rubber. (*Ref. L/T234*). By B. Gross. The British Electrical and Allied Industries Research Association, price 4s. 9d., post free.—A method given by W. Kuhn, O. Kuenzle and A. Preissmann for the determination of the relaxation spectrum from creep data is discussed. It is shown that no mathematically satisfactory theory can be formulated which does not make allowance for a finite instantaneous deformation (strain) after instantaneous loading.

First Report on Prestressed Concrete. London. Institution of Structural Engineers, 11, Upper Belgrave Street, S.W.1. Price 3s. 6d.—This report deals with the materials, stresses and design of prestressed concrete. Manufacture and construction are considered only in so far as they affect design. The recommendations given are made in the light of practical experience of prestressed concrete construction and many represent a compromise on divergent views and practice. None, it is stated, should be regarded as final. It is intended to issue a revised report when more experience has been gained and the results of further research become available.

OIL REFINERY FOR INDIA.—The Burmah Oil Company and the Shell group, partners in Burmah-Shell India, have under consideration the erection of a refinery at Bombay and the proposal is to be discussed at Delhi at the request of the Government of India.

The Design of Large Pumping Installations for Low and Medium Heads*

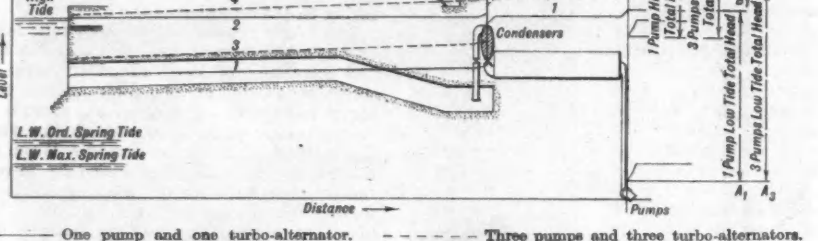
By G. A. WAUCHOPE, M.I.Mech.E.,† and H. P. HUMPHREYS, B.Sc. (Eng.), G.I.Mech.E.†

[The paper opens with an analysis of types of "rotodynamic" pumps and a consideration of their hydraulic characteristics. We reprint here an abstract from the latter part of the paper.—ED. THE E.]

CALCULATIONS REQUIRED TO DETERMINE CHARACTERISTICS OF POWER STATION CIRCULATING WATER PUMPS AND ASSOCIATED CULVERTS

IT is assumed that the plant will comprise three turbo-alternators, each having two surface condensers, and that the pumping system consists of three pumps, one for each turbine, drawing water from the sea or from a river in which there is an appreciable tidal variation.

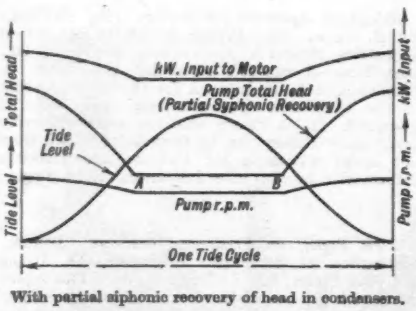
From the three pumps the water will flow through a single culvert to the six condensers, and thence by another single culvert to a point some distance away from the pumping station inlet, back into the sea or river. A diagrammatic arrangement of such a scheme is shown in Fig. 1.



———— One pump and one turbo-alternator. 1 low tide, 2 high tide.
– – – – – – Three pumps and three turbo-alternators. 3 low tide, 4 high tide.

FIG. 1—*Diagrammatic Lay-Out of Pumps, Condensers, and Culverts with Hydraulic Gradients for One or Three Pumps in Operation Under Maximum and Minimum Tide Conditions*

The problem resolves itself into a consideration of the running cost of the circulating pumps, and the capital cost of the whole system, an important part being the cost of laying the two large culverts. It should be appreciated that, if the discharge culvert from the condensers is constructed at such a low level that it is always below the lowest tide, the head against which the pumps will operate will be practically constant and will only be varied by loss of siphonic efficiency in the condensers (Guy and Winstanley, 1934).



With partial siphonic recovery of head in condensers.

FIG. 2—*Variation in Pump Total Head, Speed, and Kilowatt Input Over Typical Tide Cycle*

On the other hand, if this culvert is situated at a higher level, full siphonic recovery of the head only occurs during part of the tidal range; and during the remainder the head against which the pumps have to work is increased by the amount by which the water falls back freely into the sea or river from the outlet of the culvert. The cost of constructing a deep culvert has to be weighed against the saving in electrical consumption resulting from the reduction in head obtained.

To determine the costs involved, a diagram may be constructed in the manner shown in Fig. 1. It will be seen that this takes the form of a hydraulic gradient chart, and a number may be prepared for different levels of the culverts. Starting with the water at the lowest tide, friction in the discharge culvert from the condensers should be calculated, and the hydraulic gradient curve for the condition of one pump and three pumps working should be constructed (curves 1 and 3). A vertical section of the curve should be added to represent the friction loss and the siphonic loss through the condenser. Calculation of the friction loss in the culvert, piping and valves between the pumps and the condenser should be made, and the hydraulic gradient curve drawn. The loss through the pump suction culvert, screens and valves should be indicated by further hydraulic gradient curves and thus the maximum head with one pump or three pumps working will be shown as the distance between A_1 and B_1 for one pump and A_3 and B_3 for the three pumps. Similarly, hydraulic gradient curves should be drawn for the condition of highest tide, when the heads under this condition will be obtained. The maximum and minimum head which the pumps will have to generate at a constant quantity can thus be determined.

To predict the running cost with reasonable accuracy for one given tide, a series of similar calculations should be made taking the condition at, say, half-hour intervals. It may be considered sufficiently accurate to select a typical tide curve for the purpose, but, alternatively, for more accurate results, all the tides for twelve months may be examined and reduced to a series of, say, five or six typical tides, the current consumption for each then being calculated; these can be duly weighted from a knowledge of their frequency of occurrence and the total current consumption for the year estimated.

An important decision is the most economical means of keeping the pump discharge approximately constant with varying head, and having obtained the head variation with maximum and minimum tide from the above calculations, the most suitable type of speed control must be considered. The combined efficiency of the pump and the motor for the varying heads can then be obtained.

The results of these calculations can be indicated in a diagram of the form shown in Fig. 2, illustrating the effect of the level of the outfall from the condenser discharge culvert, the head remaining practically constant while the culvert is submerged (*AB*). Having obtained this information, the capitalisation of the running costs, taking into account the load factor, should be compared with the cost of the construction of the discharge culvert at various levels.

Where the tidal variation is not as great as has been indicated in Fig. 2, it is still helpful to utilise the same method to arrive at a true appreciation of the pressures which will be obtained in various parts of the circulating water system, and possible variation in head owing to a different number of turbines operating with water passing through the same culvert.

EXAMPLE OF CALCULATIONS REQUIRED TO SELECT DRY DOCK DEWATERING PUMPS

The problem comprises the selection of the most economical pumping plant to discharge the contents of a dry dock into a river or the sea that may have a tidal variation of level. It is usual to decide upon a specific time for the completion of the operation, commencing with highest level of water in the dock when no ship is present, and terminating when the bottom of the dock is dry.

The pumps are usually expected to continue working until the level of water in the suction culverts is some feet below the bottom of the dock, to allow a reasonable storage volume for leakage and rainwater which will ultimately be dealt with by small drainer pumps.

It is usual to discharge below water level and therefore there will be no static head when pumping starts. The head will increase as the level in the dock is lowered until it reaches its maximum when pumping ceases; thus, the pumps are required to work with widely varying head and consequent variation in discharge rate. The problem is to determine the duty at which maximum efficiency should occur and thus minimise the consumption of energy.

Obviously if the pump is designed for maximum efficiency at the maximum head, it will be working with a reduced efficiency over a large part of the pumping time; alternatively, if it is designed for maximum efficiency at too low a head, the rate of discharge when the dock is nearly empty will be so slow that the efficiency will again be low for a large part of the pumping time. To find the most suitable point a graphical trial and error method can be used.

The maximum head should be obtained first because it is determined by the greatest heights between high water level outside the dock and the lowest level in the suction culverts, and at this head the pump must remain stable and pump a reasonable quantity. Experience shows that the best maximum efficiency head is nearly always lower than this value.

The information which should be available is as follows:—

(1) A chart showing the contents of the dock at all levels from high water level to the bottom of the dock.

(2) A unity curve of a pump of approximately the same specific speed and characteristics as that likely to be selected. (A unity curve is one in which the maximum efficiency occurs when quantity=1 and head=1.)

(3) A tidal chart so that the static head can be calculated as the difference between the level in the dock and the level outside the dock at any time after commencement of pumping.

(4) A curve showing the estimated friction and other losses in the suction and discharge culverts, gratings, valves, and so on, for varying rates of discharge.

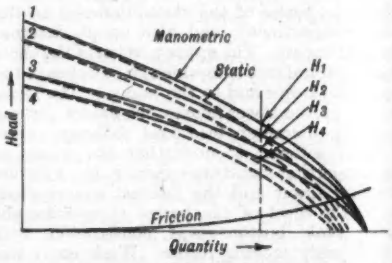


FIG. 3—*Series of Head-Quantity Curves for a Given Quantity and Alternative Heads*

Then proceed as follows:—

Assume a rate of discharge Q approximately equal to what is likely to be the maximum efficiency discharge rate; 80 per cent of the average rate of discharge may be taken as the first approximation.

Assume five or six different maximum efficiency manometric heads of reasonable values (H_1, H_2, H_3, &c.), less than the maximum manometric head corresponding to the maximum static head.

Using the unity curve referred to above, plot

* Institution of Mechanical Engineers, November 9th.

† Gwynnes Pumps, Ltd.

a series of head-quantity curves based on the quantity Q, but having a different maximum efficiency head—H_1, H_2, H_3, &c. See Fig. 3.

Plot on the same diagram the friction loss curve referred to above. Deduct the value of friction from the manometric heads, as shown dotted in Fig. 3, and these are then static head-quantity curves.

Using the dock capacity information and the tidal curve, the time to dewater for pumps designed for head H_1, H_2, H_3, &c., can be determined. The design quantity Q can then be corrected by the ratio of the calculated time to the specified time, thus obtaining new values of Q for each of the curves corresponding to different values of H, which may be designated Q_1 corresponding to H_1 and Q_2 corresponding to H_2, &c.

It can be assumed that the maximum efficiency will be approximately the same over the range of pumps under consideration; therefore $H \times Q$ will be an indication of the power absorbed by the pump.

If centrifugal pumps of the most suitable specific speed are being used, it will be found that the power can be assumed to be constant during the pumping operation, so that the value of $H \times Q$ can be taken as approximately proportional to the power consumption for dewatering operation and can be plotted as shown in Fig. 4 against the maximum efficiency quantity "Q." This curve is usually U-shaped inasmuch as for a certain value of Q the value of $H \times Q$ is a minimum. It is as well to calculate the speed of the pumps corresponding to the different values of H and Q and to plot them on the same diagram. In a similar way, it is of interest to plot the values of H.

If the pump is driven by an a.c. motor, the speed corresponding to the lowest value of H and Q may be selected, and from the curve the appropriate quantity and head for which the pump should be designed can be determined. If the selected quantity is very different from the original assumption in Fig. 3, then a correction must be made for different values of the friction loss curve.

When finally selecting the most suitable design of pump it should be remembered that the smaller the design quantity and the higher

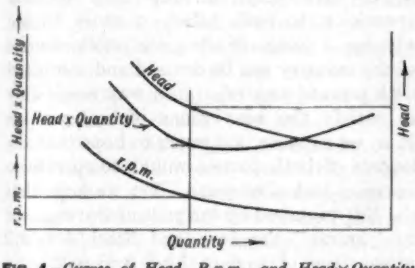


FIG. 4—*Curves of Head, R.p.m., and Head × Quantity Against Quantity*

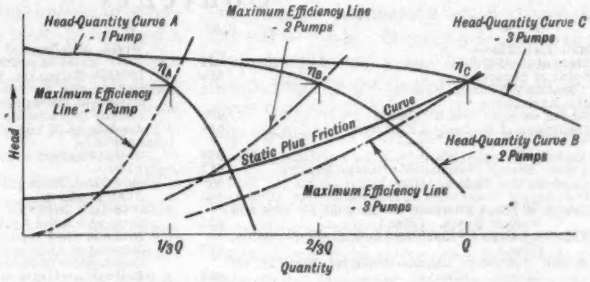
the speed, the smaller will be the electric motor as well as the pump, but that this may involve some sacrifice of economy in running cost. The ultimate decision will, of course, be a compromise between these factors.

Considerations of Factors Involved When Several Pumps Discharge Through One Pipe

Where the discharge piping is of considerable length and the consequent friction losses are important, the total head may vary considerably with the number of pumps operating simultaneously, particularly where the pumps are of different sizes.

The usual means of illustrating the problem is given in Fig. 5. Here are shown three head-quantity curves. *A* when one pump is running, *B* when two pumps are running, and *C* for three pumps. On this curve are marked the maximum efficiency points η_A, η_B and η_C, and it will be seen that, if the pumps are designed so that the maximum efficiency occurs when all three are working simultaneously, when one pump is working by itself the quantity discharged will be much greater than the maximum efficiency quantity; in certain types of pumps where the horsepower curve rises with reduced head, this may involve employing larger motors.

Where the power is large and the operation continuous the question of the use of variable-speed pumps should be investigated. Assume that it is desired that the combined quantity discharged should be in proportion to the number of pumps running simultaneously. Referring to Fig. 5, it will be seen that when one pump is working, its speed should be reduced so that its head-quantity curve cuts the curve of static head plus friction against quantity at one-third of the maximum quantity. When two pumps are working, the speed of both pumps should be reduced until the combined head-quantity curve cuts the curve of static head plus friction against quantity at two-thirds of the maximum quantity.



A one pump, *B* two pumps, *C* three pumps.

FIG. 5—*Combined Head-Quantity Curves for One, Two, and Three Pumps Operating in Parallel*

Although by this means the pump operating efficiency with one or two pumps working will not be as high as the maximum pump efficiency, it will be higher than if the pump speed had not been reduced and the discharge controlled by throttling.

Apart from the saving in energy thus effected, this control makes possible, if desired, the smooth regulation of quantity from the maximum down to a small value. The extent of the saving is largely dependent upon the proportion of static head to total head. The greater the proportion of the static head, the less justification for speed variation.

Saving in first cost may be achieved by using only one variable-speed pump and two constant-speed pumps in a set of three, but this will have a detrimental effect on the running costs, the extent being dependent upon the proportion of static head to the total head.

Curve *A* in Fig. 6 shows how, when two variable-speed pumps are used, the combined efficiency varies with the proportion of static head; and curve *B* shows the effect on the combined efficiency of using one constant-speed pump with one variable-speed pump. It will be seen that, unless the static head is a large part of the total head, considerable economy in running cost can be effected by using two variable-speed pumps "ganged" together to keep them both running at the correct speed for the performance desired. It also shows that the arrangement of having one variable-speed pump with two or more constant-speed pumps is not an economical way of operating unless the static head is a large part of the whole.

Pressure Surges in Pipe-Lines

The change of pressure in a pipe-line which results from the change of velocity of the water when the pump is started or stopped should be considered to ensure that, under all conditions of operation, this pressure will not reach such high values as to cause damage.

A high-pressure surge is practically always the outcome of a quick change of velocity and, therefore, where this can be controlled, as with diesel engine driven pumps, or with other prime movers where there is a very large amount of stored kinetic energy in the driving units, even accidental failure of the source of energy will not cause dangerous pressures. Where the drive is by an electric motor there is always the possibility of a sudden failure of the electric supply, and it is usually found that the stored kinetic energy in the rotating parts is insufficient to prevent a rapid drop in the pipe-line velocity.

A list of the usual methods of minimising the effect of pressure surge is given by Binnie and Thackrah (1951). The phenomena may be classified into the following three main types.

Type 1.—Where the length of piping is small compared with the static head, such as in dry dock pumping plant. Here, the change of velocity when the electric supply is discontinued may be exceedingly rapid and, if reflux valves are employed, serious damage may result from sudden slamming of the flaps. An automatic sluice valve has often been employed which is arranged to close by gravity at a controlled rate, so that, while return flow is permitted, the reversed velocity is reduced sufficiently slowly to avoid a high rise of pressure.

Type 2.—These conditions arise where the pipe-line is of some length compared with the static head, so that the return flow does not occur immediately and there is no danger of slamming of the reflux valve from this cause. The extent of pressure surge is dependent upon the slowing down rate of the pump and the consequent transient characteristics. These conditions cover a large proportion of pumping installations and, in many cases, the resulting stresses are not excessive.

Type 3.—Here the length of the pipe is great compared with the static head and it is possible

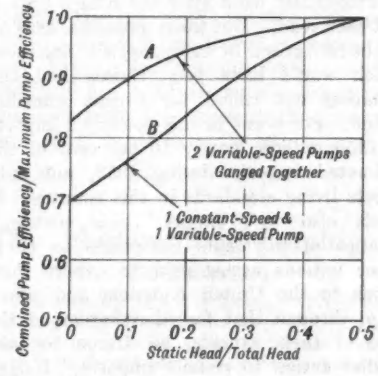


FIG. 6—*Curves Showing Influence of Static Head on Saving of Power*

for partition of the water column to occur in the pipe-line downstream from the pump. This results from the restriction of flow through the pump if its speed has fallen to a low value. The collapse of the space formed by the partition, which occurs when the water has come to rest and its flow is reversed, may set up heavy and dangerous pressures. The partition may be prevented by the use of a bypass pipe from the pump suction into the discharge, which may have incorporated in it a non-return valve of the flap type. It is sometimes necessary to employ a valve in which the rate of closing can be controlled so that the rate of change of the velocity of the reverse flow which has been permitted to take place can be kept to a low value. There are, of course, certain pressure surges which are inherent to the stopping of the pump, and can only be minimised by the use of air vessels or surge tanks.

British Plastics Exhibition and Convention.—It has been decided to hold the second British Plastics Exhibition and Convention in London in 1953. The exact dates are to be announced later. The exhibition and convention will again have the full support and co-operation of the British Plastics Federation. The organisers are *British Plastics*, Dorset House, Stamford Street, London, S.E.1.

THE ENGINEER

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THE STATE OF THE NATION

MEASURES to reduce imports, forced upon the Government by economic circumstances, were announced by Mr. Butler during that great debate upon the state of the nation that engaged the attention of the House of Commons last week after the King's Speech had been read. But those measures, as is no doubt recognised by everyone, are not those which would have been chosen had the situation not called for urgent remedial action. For a cut in this country's imports of £350 million, nearly 10 per cent of the estimated imports during 1952, not only affects living standards in this country. It tends also to "export" this country's balance of payments difficulties to those other nations accustomed to export their goods to the United Kingdom and which may, through that forced reduction of the rate of their exports, be driven to take similar action to restrict imports. Judged upon the longer term, this country needs to cure its economic weakness, a weakness that has persisted ever since the war ended, by increasing its exports. And the long-term actions of a country so heavily dependent upon imports of foods and raw materials as the United Kingdom should encourage rather than handicap the rapid development of world-wide trade.

But the bringing about of a further expansion of exports is a long-term business. Nor is it going to be any easier in future than it has proved in the past. For though industry, and particularly the engineering industry, has, during these past few years, been rapidly increasing its output, there has not been a corresponding rate of increase in the output of certain basic industries. As Mr. Butler remarked in the debate, "We need more coal than we are likely to get on present trends; we need some 1½ million tons of finished steel more than we have been able to produce or import in 1951 to meet home and essential export needs; then the transport system is working under conditions of greatest strain." He might have added in that context that we need, too, some 1000MW more of installed electric generating capacity, that many other raw materials besides steel are in seriously short supply and that whilst certain firms and industries are crying out for increased manpower other industries, through shortage of raw materials, are having to work short time. Moreover, the reduction of imports is not enough by itself to cure this country's troubles. By that means it is ensured that we buy less from abroad. But it is also assured that we have less to buy at home. The action by itself is therefore inflationary. The Government must needs also adopt measures that will have deflationary results upon the home economy. Two of them have already been announced. Excess profits tax is to be reimposed and certain fiscal measures have been adopted to check the creation of credit. But those measures, unfortunately, are likely to check the flow of capital into projects able to raise future output. Except when forced upon a nation, as they are now upon this one, those measures, too, are undesirable. For how, when no more can be expected in the coal industry than that the present decline in its manpower shall be arrested, is the output of coal to be increased unless further capital is expended upon mechanical equipment? The plan of the Coal Board to raise 240 million tons per year by 1960 is clearly well below the probable demand. Only an increased flow of capital into the equipment of the mines can raise the output sufficiently fast to make acceleration of that programme possible. Similarly, in power generation and transport a more rapid expenditure of capital on re-equipment is essential. The deficit in this country's oversea accounts—that deficit which has forced the Government to adopt such unwelcome measures—is, of course, a sign that the people of this country are living beyond their means. Yet if their standard of living is ever to be justified more capital rather than less must be spent at home. It must, however, be spent not upon raising living standards further—possibly not even upon maintaining present standards—but upon the development of that higher productive capacity that can alone justify and make higher living standards economic in the future. No wonder Mr. Butler stressed that "continued restraint in personal incomes and personal spending is as essential now as it has ever been"!

The economic signs, of course, are not all depressing. One at least of them is encouraging. As Mr. Gaitskell pointed out in a particularly well-informed speech, imports had risen in price last May by comparison with the average of the previous year by 42 per cent, whereas export prices had risen only 18 per cent. But by August import price levels had fallen back to 38 per cent above the datum, while export prices had risen to 24 per cent above it. But further favourable movement is not to be depended upon. Moreover, even if this country's oversea balance again became favourable, as it was last year, there would still be a need to increase output, not only to raise living standards here, but also to raise them elsewhere through the realisation of such schemes as those projected under the Colombo plan. Unfortunately, there comes a rub. The raising of the output of the iron and steel industry is basic to the lifting of the total output of this country. Yet, as Monday's continuation of the debate in the House demonstrated, the two political parties remain as sharply divided as ever about the desirability of the nationalisation of that industry. Mr. Strauss, indeed, seemed to suggest that if the Conservatives denationalised the industry the Socialists would hasten to re-nationalise it at the earliest moment! Under such uncertainty about the continuity of its control no industry could be expected to flourish. Clearly the two parties in the State hold strongly to their views. But for the nation's welfare, as well as for that of the industry itself, it would be better were they to drop their factious opposition to each other in order to see whether a means of adequate public control of the industry can be devised and combined with private ownership in a way reasonably to satisfy the convictions of both parties. It is, we suppose, too much to hope that the leaders of both parties would co-operate in devising such a measure. Yet we hope that the Bill promised by the present Government to "annul" the Iron and Steel Act will prove to be of such a kind and will be so presented to the House that it will receive not only the Royal Assent but the tacit assent, also, of the Opposition.

THE SPIRIT OF BRUNEL

THE assumption of office by the president of the Institution of Civil Engineers is in any circumstances a major event of the year. In this autumn of 1951, however, the installation of Mr. A. S. Quartermaine on November 6th, carried with it a deeper significance—a significance, moreover, that was twofold. The new president was the last man to hold the office of chief engineer to the Great Western Railway, and was last in the direct line of succession from Isambard Kingdom Brunel. Under the new organisation of British Railways the office, in its much amended form, will be known as civil engineer, Western Region, and will carry dual responsibility to the chief regional officer and to the members of the Railway Executive responsible for civil engineering. On the Great Western Railway the post of chief engineer originally included responsi-

bility for all engineering, of whatever kind, and as such Brunel received application for the post of locomotive superintendent from Daniel Gooch when the latter was no more than twenty-one years of age. But in the course of his delightful address, Mr. Quartermaine did not dwell upon the past in a nostalgic, or even a reflective way; his address was delivered only a few hours after the King's Speech at the opening of Parliament, and his references to the energy, the artistic merit and the broadmindedness of Brunel came both as an example and an inspiration at a time when the "economic Dunkirk" that is upon us calls for all the energy, enterprise and sheer hard work that engineers and the nation in general can muster. Brunel's work for the Great Western was begun at just such another time of political unrest and economic plight, especially in Bristol and the west; and he threw himself into the work with an enthusiasm and gaiety that was infectious and with an energy that readily sustained him during his customary twenty-hour day.

With Brunel brought thus so vividly to mind, it was natural that Mr. Quartermaine should remind his hearers of some of the more outstanding works included in the construction of the original main line of the Great Western—from London to Bristol. In so doing he introduced a pleasing contemporary touch by exhibiting lantern slides made, not from photographs, but from the exquisite drawings of J. C. Bourne, in which the architectural beauty of Wharncliffe Viaduct, of the Thames bridges at Maidenhead and Basildon, and of the interior of the Bristol terminus station was displayed no less effectively than the dramatic impression of the interior of Box tunnel in that portion where the bore, in the form of a great Gothic arch, was hewn out of the oölite and left unlined. Mr. Quartermaine told of the speed with which the work was done; for although there was no labour shortage at that time, there were, equally, no tools other than picks, shovels and gunpowder, and no means of haulage other than by horse. Mr. Quartermaine added, a little wistfully we thought, that Brunel did not have to deal with a Ministry of Town and Country Planning! In selecting his one example of Brunel's work that lay beyond the confines of the original London-Bristol main line, the beautiful Royal Albert Bridge over the Tamar at Saltash, Mr. Quartermaine emphasised another facet of Brunel's complex personality—the artistic excellence of all he did.

The address was very far from confined to a review of the past. It stressed the point that amid the difficulties that are besetting the civil engineering departments of British Railways there are opportunities for original and inventive work as great as when Brunel built the Great Western Railway. Then all was concentrated on new construction; now the need is for improved, if not revolutionary, methods for the more effective maintenance and enhancement of the quality of the road. There is an ever-present need and opportunity for first-class brains in the railway engineering service—men with hard-headed railway experience. To quote Mr. Quartermaine verbatim: "mediocrity and accountancy will not be sufficient." Already new methods and increased mechanisation are being introduced into the maintenance of permanent way. Major operations, necessitated more often by the ageing of the track formation rather than by deterioration of structures, many of which are now more than a hundred years old, have been carried through in several parts of the country. The problems of to-day are by no means wholly those of engineering. Instancing Brunel's wide general interests as a factor that probably contributed towards making him a successful administrator, Mr. Quartermaine urged engineers in general to make sure they were well represented when administrative matters concerning them were under discussion, and by their own leadership to foster enthusiasm and pride of achievement among their own staff. The railways must advance in engineering technique as in other branches of the service. For many years past, however, it has been evident that the Great Western was fortunate in its chief engineer, a man who even in these unspectacular days himself showed more than an occasional touch of the Brunel spirit. His retirement from the railway service coincides with his installation as president of the Institution of Civil Engineers, and his fellow members made November 6th an occasion for felicitations on both counts. Returning to the historic character of the address, we conclude, as Mr. Quartermaine did, by quoting the words of Joseph Locke, in November, 1859, when himself president of the "Civils." In referring to the death earlier that year of both Brunel and Robert Stephenson, he charged members of the Institution "to honour their memory and to emulate their example."

THE "ECONOMY" CAR

For the last four years in all our Motor Show reports we have emphasised our opinion that economic conditions, not only in this country but on the Continent as well, will eventually compel the motor industry to concentrate on cars of a more utilitarian character, designed mainly for domestic markets and to make motoring cheaper. A fortnight ago we again stressed that point in a discussion in these columns of the general trend in automobile engineering, as reflected at the recent London Motor Show. In particular we welcomed the appearance of the rejuvenated Austin "Seven" as a distinct step in this direction and expressed the hope that more manufacturers might follow Austin's example. We now learn that Sir John Black, head of the Standard Motor Company, plans to give a lead to the British motor industry in the production of a light economy car which will give efficient motoring at lower cost than any other car manufactured in this country to-day. Sir John Black hopes to supplement the range of Standard and Triumph cars with one which will meet, in particular, the needs of the lower-income groups. The new car is intended, we understand, to have an engine smaller than any in normal production on the British market, with a cylinder volume not exceeding 700 cc, and to provide an ample performance at very low fuel consumption. It has been stated that prototypes have already been severely tested. But it is unlikely that production will begin for some eighteen months or so. No details have been made available about the design of the new car, but we hope, perhaps optimistically, that some novel and unorthodox approach to the old but nevertheless difficult problem of designing a satisfactory small "economy" car will be made. It can, no doubt, be argued that the price of a car is fixed less by its design than by the cost of raw materials. We agree that the latter cost is, indeed, of major importance. But if a designer can cut down the dimensions and the weight of a car to a practical minimum which will not too much affect the performance and the road-holding properties of the vehicle, then the saving of material can reduce the price in almost direct proportion. Moreover, the design of a small car allows the designer more freedom than might at first glance be supposed to be available. For there is no need to adhere to some orthodox pattern, since buyers would probably accept any honest functional shape providing it served the desired purpose and was relatively cheap. This freedom of choice applies not only to the general lay-out but to practically all major details. Two and four-stroke engines, either air or water-cooled, and with several different cylinder arrangements, are possible, and so are front-wheel drive or rear-engine mounting, integral body or separate chassis construction of tubular or pressed steel. In short, the limitations are so few that the choice amongst the variety of possible designs itself imposes difficulties. But we are certain that British engineers, once they have actually concentrated on this task, will find solutions satisfactory even to motorists more discriminating than many of those likely to purchase the car.

The Shipbuilding Employers' Federation

The election of office bearers of the Shipbuilding Employers' Federation took place at the annual general meeting of the central board, which was held in Edinburgh on November 8th. Mr. Charles Connell has been succeeded as president by Mr. A. Lewis Cochrane, who is chairman and managing director of Cochrane and Sons, Ltd., and is the third generation of the family to control the company. Mr. Cochrane has been a member of the Federation's central board and of the executive committee for many years and was a member of the conference and works board from 1937 to 1942, being chairman in 1942. He is also the vice-president of the Hull Iron Trades Association. Mr. John G. Stephen, a director of Alexander Stephen and Sons, Ltd., has become senior vice-president, while the other vice-presidents appointed were Mr. T. Eustace Smith, joint managing director of Smith's Dock Company, Ltd., and Mr. Charles A. Winn, joint managing director of C. H. Bailey, Ltd. Mr. Stephen is the president of the Clyde Shipbuilders' Association and a director of the African Lakes Corporation. Mr. Eustace Smith is the fifth generation of the family to become head of Smith's Dock Company, Ltd., and the third vice-president, Mr. Charles A. Winn, is a director of the Bristol Channel Dry Dock Owners and Ship Repairers' Federation, Ltd., and a past chairman of the Bristol Channel Ship Repairers' Association. The new chairman of the conference and works board is Mr. Robert Cousland, shipbuilding manager of J. Samuel White and Co., Ltd., and Mr. Hugh H. Hagan, who is a director of Lobnitz and Co., Ltd., and of The Ailsa Shipbuilding Company, Ltd., is the new vice-chairman of the board.

Obituary

SIR PEIRSON FRANK

We regret to record the death of Sir Peirson Frank, which occurred suddenly on Monday last, November 12th, at his home at 8, Chartfield Avenue, Putney, London, S.W.15.

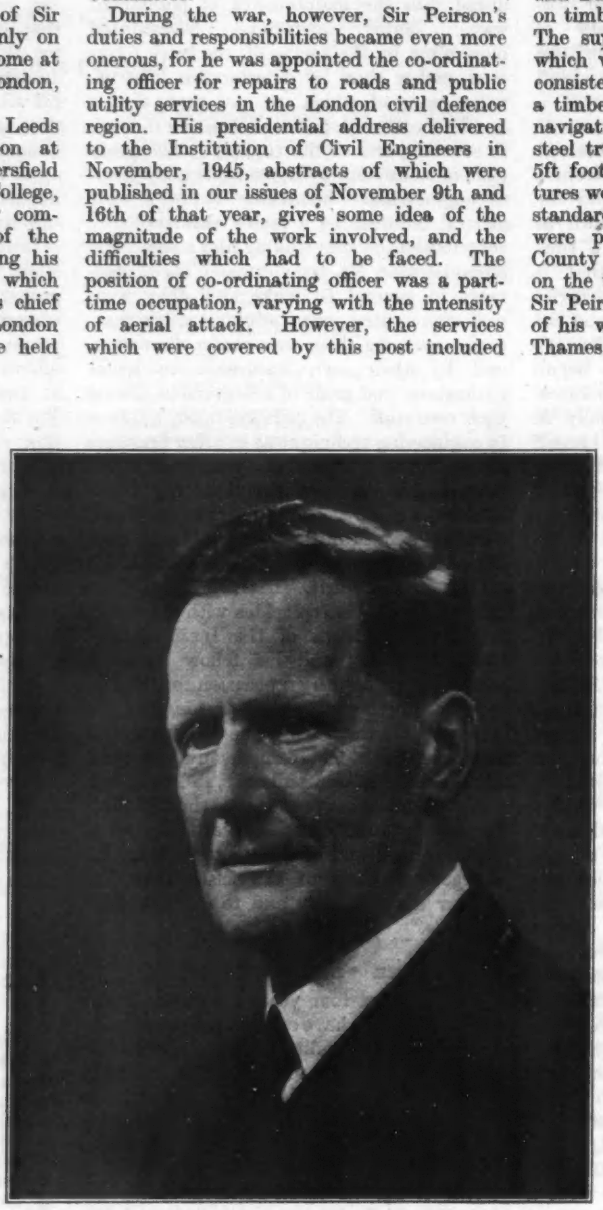
Thomas Peirson Frank was born at Leeds in 1881. He received his education at Pickering Grammar School, Huddersfield College and Huddersfield Technical College, and at the end of the last century commenced a pupilage on the staff of the Huddersfield Corporation, thus starting his long career as a municipal engineer, which eventually led to his appointment as chief engineer and county surveyor of the London County Council, a position which he held from 1930 to 1946. In 1903 he joined the staff of the borough engineer of Dewsbury, and he then held the positions of city surveyor of Ripon from 1908 to 1912, borough surveyor and water engineer of Newark-upon-Trent from 1912 to 1915, and borough engineer and surveyor at Stockton-on-Tees from 1915 to 1919. During this last period, however, Sir Peirson saw service with the Royal Engineers, in which he held a commission. In the spring of 1917 he was given command, with the rank of Captain, of the 196th Land Drainage Company, R.E., and in August of that year he became a casualty.

Sir Peirson left Stockton-on-Tees in 1919, to take the post of borough engineer and surveyor of Plymouth, which he held until 1921. He then became city engineer, architect and surveyor at Cardiff, and a year later was appointed honorary surveyor of the East Glamorgan Regional Planning Committee, a position which he held until 1926.

Prior to his appointment as chief engineer of the L.C.C. in 1930, Sir Peirson had served as city engineer and surveyor at Liverpool, where he had also been honorary surveyor to the South-West Lancashire Regional Town Planning Advisory Committee and a Special Lecturer in the Department of Civic Engineering and Hygiene at Liverpool University. His sixteen years with the L.C.C. included a period of considerable activity in the work of the chief engineer's department before the outbreak of war, during which the works carried out under his direction included the installation of modern power units at seven of the L.C.C.'s large main drainage pumping stations, the construction of an appreciable mileage of tunnel sewers, new purification works to treat 60 million gallons per day, and the production of sludge gas at the Northern Outfall Works. Other important works included the widening of Putney Bridge, the building of a new bridge at Wandsworth, and in co-operation with the consulting engineers the demolition of the old Waterloo Bridge and the construction of the new one. Sir Peirson was also responsible for a number of road improvement schemes and housing developments during this period, and served on several Government committees, including the Highways Research Board and the Ministry of Transport Experimental Work on Highways Committee.

During the war, however, Sir Peirson's duties and responsibilities became even more onerous, for he was appointed the co-ordinating officer for repairs to roads and public utility services in the London civil defence region. His presidential address delivered to the Institution of Civil Engineers in November, 1945, abstracts of which were published in our issues of November 9th and 16th of that year, gives some idea of the magnitude of the work involved, and the difficulties which had to be faced. The position of co-ordinating officer was a part-time occupation, varying with the intensity of aerial attack. However, the services which were covered by this post included the maintenance of roads and bridges; the restoration of damage to sewers, water (including hydraulic power) and gas mains; electricity and telecommunication cables and the Thames flood defences. In addition, special precautions were necessary for the underground and Thames tunnels, and for keeping certain works in operation throughout a period of preparation for D-Day. The damage which would have been inflicted on London due to the breakdown of any of these public utility services would have been extremely serious, and it was through prompt and often ingenious repair work or precautionary measures that such breakdowns were avoided. The detailed account of this work which Sir Peirson gave in his Presidential Address thus makes very interesting and instructive reading.

He recorded, for example, that among the protective measures taken was the erection of three temporary bridges across the Thames, between Victoria Embankment and the County Hall; Grosvenor Road and Albert Embankment, and Chelsea Embankment and Battersea Park. They were supported on timber piles protected by timber staging. The superstructure of the approach spans, which was 44ft between centres of staging, consisted of steel stringer joists supporting a timber deck. Each bridge had two main navigation openings, spanned by 140ft steel trusses. A 20ft carriageway and two 5ft footpaths were provided and the structures were designed for Ministry of Transport standard loading. Most of the materials were purchased directly by the London County Council and the total expenditure on the three bridges amounted to £132,000. Sir Peirson added in this part of the record of his work that a fourth bridge across the Thames, somewhat similar in construction, was erected at Staines by the county engineers of Middlesex and Surrey.



SIR PEIRSON FRANK

Sir Peirson retired from the L.C.C. on reaching his sixty-fifth year, in 1946, and soon afterwards started to practise as a consulting engineer as a partner in the well-known firm of Coode, Vaughan-Lee, Frank and Gwyther. During his five years as a consulting engineer the civil engineering works with which he was principally concerned were the Connaught Bridge power station in Malaya; Pasir Panjang power station, Singapore; an extension of the boiler-house at Melbourne power station, and the tunnel under the Thames at Long Ditton for the South-Eastern Gas Board. He was also concerned with reports on flooding and sea defence works at Chesil, a flood protection scheme on the River Irwell at Salford, a general report in connection with the storage of water for irrigation in British Guiana, and designs for bridges in Nigeria at Cross River, Gongola, Garafini and Foggo.

Sir Peirson was elected an associate member of the Institution of Civil Engineers in 1906, was transferred to full membership in 1922, and, as previously mentioned, became president of that Institution during the year 1945–46. He was also a Fellow of the Surveyors' Institution, a member of the Institution of Municipal and County Engineers, a Fellow of the Royal Sanitary Institute, and he held the presidency of the Town Planning Institute during the year 1944–45. The honour of knighthood was conferred upon him in 1942. Sir Peirson was also a Colonel of the Engineer and Railway Staff Corps, R.E., Territorial Army, and he received the Territorial Decoration.

ALLAN FERGUSON

We have learned with regret of the death of Dr. Allan Ferguson, which occurred at his home at 88, Hadham Road, Bishop's Stortford, on November 9th. Until his retirement in 1945, Dr. Ferguson was Assistant Professor of Physics at the Queen Mary College, Mile End, London.

Allan Ferguson was born at Entwistle,

near Bolton, on May 11, 1880, and was educated at the Harris Institute, Preston, and University College, Bangor. After obtaining his degree at Bangor, he was for a time an assistant lecturer in physics at the College, and later became lecturer in physics at the Manchester College of Technology. In 1928, Dr. Ferguson was appointed secretary of the Physical Society and continued in that office until he was elected president of the society ten years later. But Dr. Ferguson will also be particularly well remembered by his work as general secretary of the British Association for the Advancement of Science, which position he occupied from 1936 to 1946. He also served as president of Section A, Mathematics, of the British Association in 1936. For some time Dr. Ferguson was Editor of the *Philosophical Magazine*, and from 1939 to 1940 was an advisory editor of *Nature*. Another important office in which he served was that of examiner in natural philosophy to the University of Glasgow from 1940 to 1944.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

HOSPITALS, INSTITUTIONS AND THE ENGINEER

SIR,—I am sorry to learn, from their letter which you published on November 2, 1951, that Messrs. Knighton and Evans think they have occasion to find fault with my recent address to the Institution of Engineers-in-Charge. They express concern about that part of the address which criticised acts and omissions of the Ministry of Health and of Regional Hospital Boards as one result of which several of those Boards are, I said, "attempting to meet their engineering responsibilities by the appointment of assistant engineers in their Architects' Departments." I said that this, among other things with which your present correspondents do not concern themselves, was "all wrong."

Messrs. Knighton and Evans consider that I said much that could be prejudicial to good relationship of architects and engineers, and refer to me as using a strident tone in criticism of architects. I do not think that I criticised architects at all. It is true that I mentioned limitations of the architectural profession in view of which architects are not qualified to have charge of engineering. If that is criticism of architects then I also criticised engineers, for I explicitly excluded architecture from any field of which I suggested that engineers should have charge.

The observations of my two critics are really based upon things that I did not say and inferences for which I cannot be held responsible. Thus, in their first paragraph they say that THE ENGINEER reports me as having criticised "the practice of Hospital Boards in putting an architect in charge of maintenance of hospital premises." The inverted commas are theirs, but the phrase which they thus put forward as a quotation from your report is not to be found therein; I did not use it, nor does it represent anything that I said. In the same paragraph they say that my address condemns the present arrangements for carrying out both engineering and building maintenance and new work. As regards building this is not the case. I agree that it is accurate in respect of engineering only.

The only basis I can find for their idea that I condemned the building arrangements is their misreading of a passage in which I suggested that engineers could make a better job of building maintenance—not of architecture—than architects can make of engineering. I can conceive that an architect might disagree with me; I cannot conceive that he could feel any grievance against the engineer who holds and expresses that opinion, to which I adhere. In the same passage I said, "If Regional Boards wished to combine and co-ordinate engineering and building functions in one department they would have been better advised to make the Regional Engineer the head of that department." To this Messrs. Knighton and Evans take exception. They seem to think it is opposed to their view that there is ample room in the hospital service for both Regional Architects and Regional Engineers. The present position is that all fourteen Regional Boards have appointed Regional Architects, but only five of them have appointed Regional Engineers. I did not dispute the room for the architects; I did maintain that there is not only room, but also need for Regional Engineers in the interests of the hospital service and of the national purse.

My two critics suggest that my views are attributable to a vague feeling that I should like to see the National Hospital Service adopt the system that I knew in the service of the London County Council. There is not the slightest ground for their imputing this motive to me. Nor am I the least bit vague about it that engineers, and not architects, should be responsible directly to the Boards for all engineering, a case the strength of which does not depend at all on what may or may not have been the practice of the L.C.C. If Messrs. Knighton and Evans contested that case and advocated the management of engineering by architects, then, indeed, there would be contention. But from their own statements I think I can claim their support, and they may find, on reflection, that there is no real or substantial difference between us.

ROBERT CHALMERS

London, S.E.10, November 9th.

PRESENT-DAY LOCOMOTIVE WORKING

SIR,—In view of the conflicting reports which have been sent you regarding the accident on the Great Eastern Railway, caused by the detachment of a balance weight, I have verified and found accurate the facts as given by the late E. L. Ahrons. I find that the accident to No. 609 occurred at Stretham Fen on July 28, 1882. The inspecting officer, Colonel Hutchinson, reported that the damage to No. 609, which finished on its side in a dyke, was such as to indicate that its left leading bogie wheel struck the balance weight from No. 602 with consequent derailment. The reversing gear balance weight from No. 602, which fell on to the down track, had become detached a few minutes before the trains passed each other. A synposis of the inspecting officer's report appears in THE ENGINEER for October 27, 1882.

F. A. S. BROWN

London, S.W.1, November 8th.

ASSESSMENT OF LOCOMOTIVE PERFORMANCE

SIR,—As an assistant controller employed on the L.N.E.R. main line control during the years 1922–40, I was concerned with the running of the up and down "Coronation" trains as between Shaftholme Junction and Skelton Bridge, just north of York, and vice versa. My experience on the control board was that the down "Coronation" was a remarkably good timekeeper, usually entering our control area anything from 2½ minutes to half a minute early and arriving at York about on time. Apart from delays due to unforeseen contingencies, such as engine failures or derailments, I seldom knew this train, which was usually worked by an "A.4," to run late.

As a matter of interest I might mention that on one occasion when the down "Coronation" for some reason consisted of an ordinary vestibuled train set, the train engine (an "A.4") failed on arrival at York and the train was worked forward by a "V.2." We three controllers on the main line control board all wondered how the "V.2" would manage to cope with the "Coronation" timings from York to Newcastle. It did well, only losing six minutes on the run from York to Newcastle Central.

NORMAN DUNCAN

York, November 5th.

Universities and Industry

THE Anglo-American Council on Productivity has published this week a report entitled "Universities and Industry." It has been prepared by a team representing British industry, universities and technical colleges, and the Ministry of Education, which visited the U.S.A. earlier this year to investigate the relations between the universities and industry in that country. Dr. Percy Dunsheath, M.I.E.E., was the leader of the team. The inquiry was not concerned with the detailed factors affecting industrial production but with the lessons that might be learned from the U.S.A. on the broad issue of the university-industry relationship and the extent to which that relationship could contribute to the national prosperity. During its tour of the eastern part of the U.S.A. the team visited seven universities as well as a number of degree-granting colleges and institutes of technology. The programme also included conferences with individuals and groups representing various professional bodies and manufacturing interests. The report summarises the organisation, curricula and outlook of American universities and colleges, especially from the viewpoint of engineering and science education. The team says that it found in the U.S.A. a keen and widespread interest in college education and, compared with this country, a more extensive provision of facilities for such education. It adds that a high proportion of those who enter American colleges leave before they have completed a degree course, a practice which in the U.S.A. is not looked upon as extravagant and educationally undesirable. Most engineers in American industry, the report records, have received their education in degree-granting institutions, there being no considerable alternative source of supply comparable with that which is forthcoming from the technical colleges of Britain. One of the recommendations which the team makes in its report is that immediate attention should be given here to the provision of facilities for preparing a large number of young men for industry, giving them a broad general education on a full-time basis with a technical standard at least as high as that of the Higher National Certificate courses. It is urged that close study should be given to the problem of how and where such men should be educated and that efforts to secure a solution of the problem in this country should be intensified.

Literature

BOOKS RECEIVED

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Neglect of Science. By F. E. Simon. Oxford: Basil Blackwell, 49, Broad Street, Oxford. Price 8s. 6d.

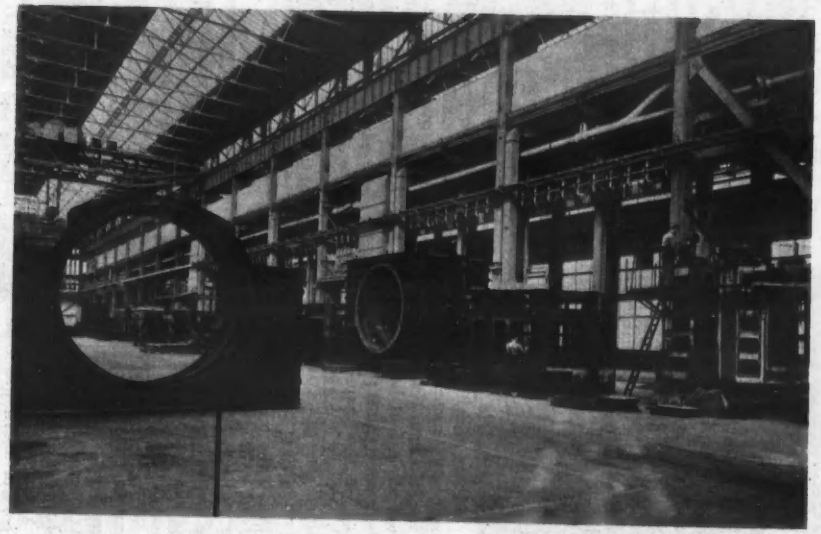
Directory of International Scientific Organisations. London: H.M. Stationery Office, Kingsway, W.C.2. Price 6s.

Grenzschicht-Theorie. By Herman Schlichting. Karlsruhe: Verlag und Druck G. Braun. Price D.M. 45.

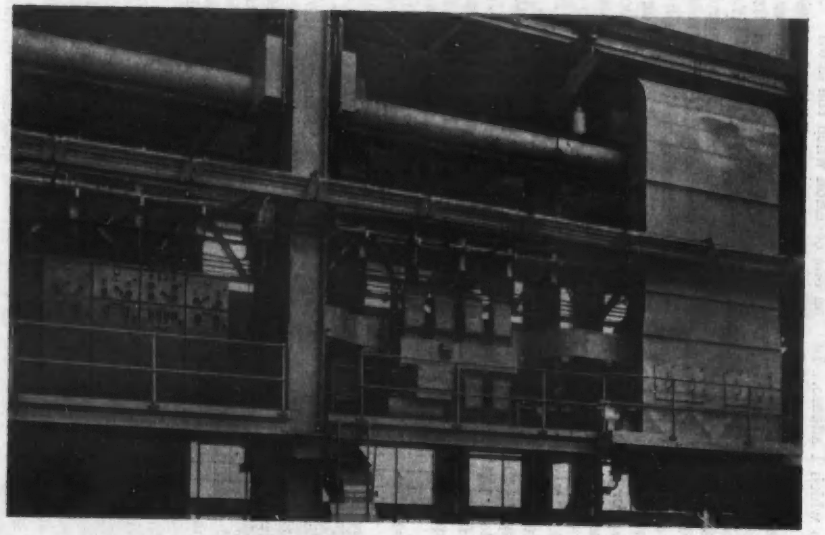
First Hundred Road Motors. By R. W. Kidner. Surrey: The Oakwood Press, Tanglewood, South Godstone. Price 9s.

Foremanship: A Textbook. By F. J. Burns Morton. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 25s.

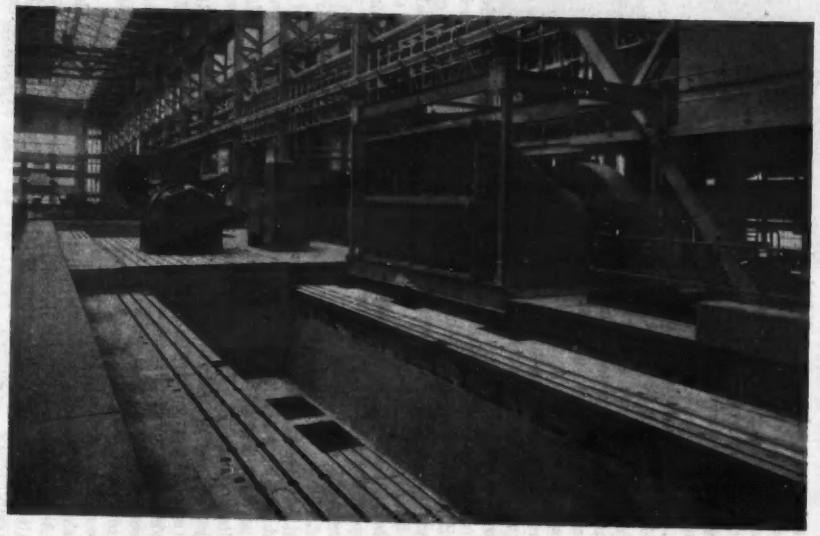
TURBO-ALTERNATOR WORKS EXTENSION AT WITTON



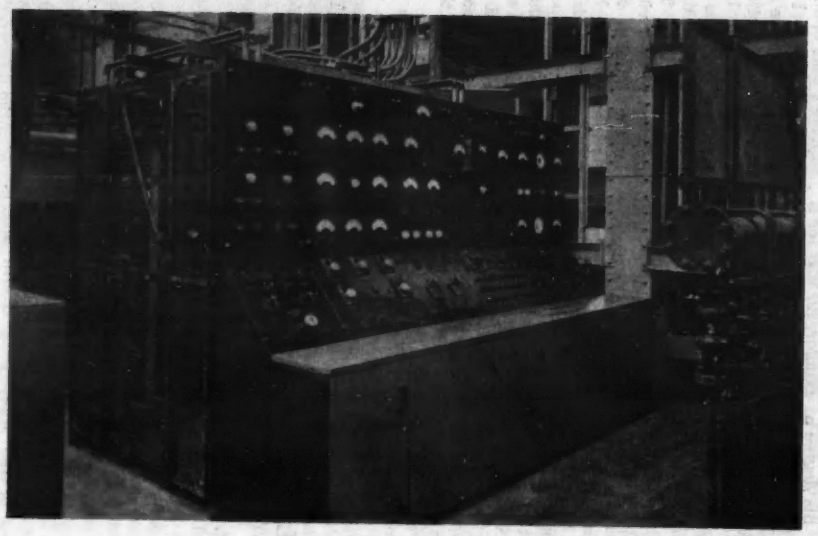
MAIN ERECTION BAY



PART OF HEATING AND VENTILATING PLANT



ALTERNATOR TEST BED

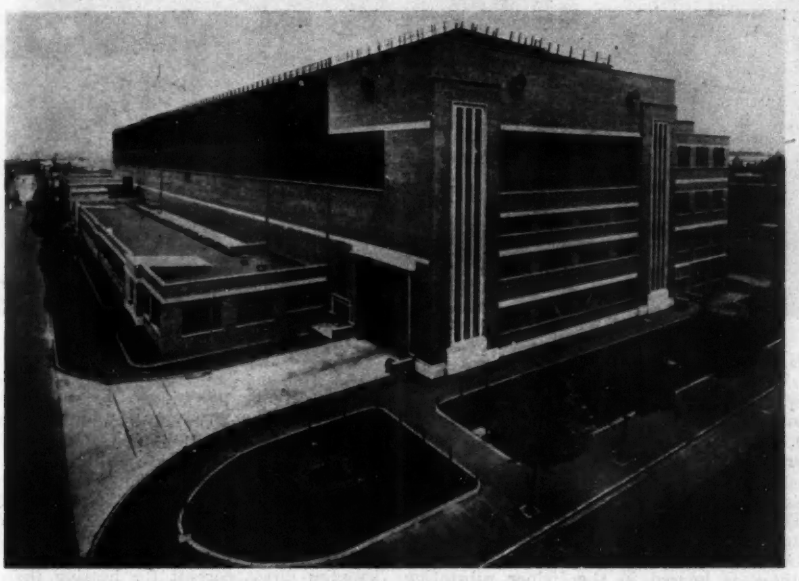


MAIN CONTROL BOARD ON TEST BED

Turbo-Alternator Works Extension at Witton

AN important addition to Great Britain's capacity for manufacturing heavy electrical plant was demonstrated a week ago when a party of some 200 visitors made a short tour of the new heavy engineering works of the General Electric Company, Ltd., at Witton. As far as large electrical generating plant is concerned, the new works, when in full operation, will be capable of doubling the present output from Witton. It will, however, do more than that, for although the shop has been planned primarily for building and testing large steam and water turbine driven alternators, it will also be used for the manufacture of motors for rolling mills, winders and ship propulsion.

These increased manufacturing facilities, besides having a direct effect on the output of large rotating machines, will reduce the load on the older engineering shops in the Witton works and will, therefore, have a beneficial influence on production generally. Machining operations will continue to be done in the old shops, the new works being devoted entirely to assembly and testing—a division of functions which simplifies the task of arranging production flow in the new building, from the entrance, which can be seen in the foreground of the above illustration, to the exit at the other end of the building.



NEW HEAVY ENGINEERING WORKS AT WITTON

The new building covers an area of about 2½ acres and runs due east and west, with a frontage on Electric Avenue in the background of our illustration. Occupying the full length of the building is the main erection and test bay, which is 525ft long by 100ft wide in a single span, the height to the eaves being 70ft. From the core building pits, which are at the near end of the building shown in our illustration, erection and assembly proceeds along the length of the shop, rotors on the left of the bay and stators on the right. At the far end of the bay the erected machines enter the testing section from which there is access to Electric Avenue. Lifting facilities in the main bay are provided by two 110-ton overhead travelling cranes which serve the full length of the building and jointly provide for a maximum lift of 200 tons. The crane rails are at a height of 58ft 6in above floor level.

At the east or incoming end of the main bay are four core building pits, 6ft deep, each equipped with a hydraulic jack for compressing the core stampings. Three pits are designed for a total loading of 200 tons, and the fourth for 50 tons. Facilities are provided for ring flux testing of the cores both during assembly and when completed.

On the south side, and almost at the end of the erection section, is an electronic dynamic balancing machine, designed in the company's development laboratory and capable of balancing rotors up to 50 tons in weight to an accuracy of a tenth of an ounce at the periphery. Beyond the rotor balancer, at the west end of the bay, are the various test beds, occupying a floor space of about 160ft by 100ft, which include the raised bed for turbo-alternators, the overspeed rotor test pit and the test bed for water-wheel alternators, each of which is illustrated herewith. The two main doors to the building are situated at the south-east corner and west end of the main bay respectively, and they are motor-operated concertina units.

Along the full length of the building on the north side is a bay 40ft wide, about half of which is devoted to forming the rotor windings and to certain finishing processes on the stator coils. This section, which is 40ft high, is served by a 10-ton overhead crane. The remainder of the north bay is devoted to stores and office accommodation, the stores being arranged on two floors, 24ft and 16ft high respectively, with central columns which divide each floor into two 20ft bays. To serve the ground floor stores there are two 3-ton underslung travelling cranes, one in each bay, cross-overs being arranged so that loads can be transferred easily from one bay to the other. A similar crane also serves the upper floor of the stores.

A passenger lift and a 2-ton goods lift are situated between the stores and winding section, above which is a further floor extending the full length of the building. With the exception of the drawing-office accommodation at the west end, the whole of the top floor is devoted to the manufacture of stator coils and the formers used for this work. A 2-ton travelling crane runs the length of the stator coil section, transport of the coils to the ground floor being provided by a 5-ton dual capacity lift at the east end of the building. This lift, supplied by the Express Lift Company, Ltd., is designed to handle loads of 2 tons at 150ft per minute or 5 tons at 50ft per minute, the change-over being effected readily by the attendant without leaving the lift cage. The cage is 28ft long by 10ft wide and accommodates an aluminium truck with a mahogany top on which the coils are loaded. Rails in the floor of the cage register with similar rails in the floors of the two winding bays.

The indoor substation, which houses the power plant and all associated switchgear required for test purposes and power distribution in the works, is situated at the south-west of the building next to the test beds, and covers an area of some 6800 square feet. Immediately to the east of this building is an outdoor transformer and reactor substation. As shown on the left of our first illustration, a single-storey office block extends along the remainder of the south side of the works, from which it is separated by a light well, 15ft wide. Besides accommodating administrative staff, the new building will house the education and training department, technical library and lecture theatre with a projection room.

All essential services for the works are run high above floor level; they include power and lighting cables, heavy current busbars, a 150 lb per square inch steam main for process work, a low-pressure steam main for heating, the condensate main and compressed air and gas mains.

Alternator Test Bed

The main test bed for the steam-turbine-driven alternators is 133ft long by 19ft wide, and comprises an 8ft high central platform on either side of which is an alternator bed 50ft 6in long and 6ft 3in above the shop floor. With this arrangement one machine can be erected or dismantled while a second is on test. Each of the alternator beds is built to form a pit below the machine and is provided with air ducts for the closed circuit ventilation of air-cooled alternators. A hydrogen detraining tank forms part of the test equipment so that hydrogen-cooled alternators can be run under operating conditions. Our illustration of the test bed shows the driving motor and the removable platform carrying the fans and cooler for the air-cooled alternators.

Arrangements are made whereby all alternators can be tested at full voltage and current, two saturable reactors being provided whereby loads up to 100MW at very low power factor can be imposed on the machines. Tubular copper busbars, 4in diameter and ⅜in thick, connect the alternator to the reactors. These busbars are suitable for voltages up to 22kV, their large diameter minimising skin effect and eliminating any risk of corona.

Particular attention has been given to the lubrication system. In the event of a breakdown of the oil pumps a header tank, designed for a working pressure of 50 lb per square inch and having a capacity of over 2000 gallons, ensures an adequate supply of oil to the bearings during the time taken to shut down the plant.

For complete tests, constant speed with no risk of overspeed is essential. For this reason the driving motor, which is mounted on the central platform, is an induction machine, connected through two induction regulators and a 2000kVA step-down transformer to the 11kV supply from the Midland Electricity Board. The regulators give a variable voltage from 0V to 760V to meet the requirements of starting and stopping the plant on test. They may also be used to provide a supply when reactance measurements are being made of the stator windings. The motor is rated at 2000 h.p. at 2950 r.p.m., and has a double shaft extension so that it can be coupled up readily to alternators mounted on either of the test beds. In the event of greater driving power being required, a second motor can be coupled in tandem.

A steel platform extends the full length of the test bed on the south side. Two removable sections, each 20ft 6in long by 13ft 9in wide, are provided adjacent to the alternator beds. On one are mounted the fans and coolers for air-cooled alternator ventilating system and, on the other, the hydrogen and CO_2 control panels, gas supplies, &c., for hydrogen-cooled alternators. These platforms can be interchanged as required.

The control board, shown on page 628, from

which the whole of the test plant is operated, is situated on the steel platform alongside the middle section of the test bed.

Rotor Overspeed Pit

The overspeed pit, illustrated herewith, is situated on the north of the test area, and is designed to accommodate rotors for turbine-driven alternators. It is of heavily reinforced concrete construction, employing some 300 tons of steel, and is over 60ft long by 11ft wide between the concrete sides. Over a length of 37ft 6in the sides of the pit are protected by steel boxes filled with sand and set in panels 5ft 6in deep. A final facing of timber, 10in thick, completes the provision made to absorb the great amount of energy which would be released in the unlikely event of a large rotor bursting on overspeed. An escape tunnel with entrances at each end extends the full length of the pit. The pit is completely covered by seven slabs, each weighing 30¼ tons and constructed from rolled steel joists and 1¼in thick flange plates. The box section thus formed is filled with concrete. A sand-filled steel box, faced with thick timbers, forms the underside of the slab. These slabs are secured by heavy cast iron wedges, so that the entire covering is dovetailed in position. Ventilation is provided by a centrifugal fan which draws air from the pit and discharges it to atmosphere through a circular duct under the stores floor.

Since variable speed is essential for overspeed testing, a direct current motor, arranged for Ward Leonard control, drives the rotor through speed increasing gears. The motor is rated at 2000 h.p. and is designed for a voltage range of 0/600/750V and for speeds up to 900 r.p.m. With Ward Leonard control rapid starting and stopping can be achieved, and full use made of the regeneration of power when closing down the test. The motor and gearing are mounted on a bedplate to form a self-contained transportable unit, which can be lifted readily from the pit, and used to drive a variable-frequency alternator for the overspeed testing of water-wheel alternators. Lubrication arrangements are similar to those provided for the main test bed, and include a header tank which operates at 50 lb per square inch pressure and a main storage tank situated in a pit 28ft deep at the north-west corner of the overspeed pit. The test control board is mounted on floor level to the west of the pit and is a flat-back panel.

Water-Wheel Alternator Test Bed

The water-wheel alternator test bed shown in one of our illustrations covers a floor area approximately 44ft in diameter and comprises a central pit 8ft diameter and 6ft 6in deep, from which radiate cast iron floor plates arranged symmetrically to form eight legs on which the alternator and test equipment is mounted. At the bottom of the pit is a 100-ton hydraulic jack on which is mounted a ball bearing to carry the weight of the alternator rotor on starting. As soon as rotation begins the oil enters the Michell thrust bearing of the alternator and the jack is released.

The tests which are undertaken for water-driven alternators include the determination of open and short-circuit characteristic curves and the measurement of losses, as well as overspeed testing.

A 2000 h.p. direct current driving motor is mounted on top of the alternator in place of the exciter. It is Ward Leonard controlled and provides a speed range from 0 to 800 r.p.m., so that in many cases it can be used for running the alternator at overspeed. Where higher speeds are required, the alternator, complete with its exciter, is run as a synchronous machine, and is supplied with variable frequency from an alternator rated at 5000kVA, 6000V, with a frequency range up to 150 c/s. As already mentioned, this machine is driven by the 2000 h.p. geared d.c. motor, normally used in the overspeed test pit.

Substation Equipment

The power plant for all test requirements, which includes two motor generators, two induction regulators and a grid-controlled rectifier, is housed in the indoor substation together with the high and low-voltage switchgear for test and works supplies. Immediately to the east of this building is the outdoor substation where seven transformers and two saturable reactors are installed. Two air-blast water-spray coolers are also situated in this area. One is for the water from the oil cooler and the hydrogen and air coolers in the closed ventilating circuits of the alternators on test, and the other for the electrolyte from the liquid starter for the 2000 h.p. driving motor on the alternator test bed.

Three incoming supplies are available as follows: first, two 11kV feeders, one from the M.E.B. network and the other from the works power station; secondly, a 460V, three-wire d.c. supply for the cranes and general works services; thirdly, a 400V, three-phase, four-wire supply. It is an emergency feeder for essential test plant auxiliaries, and is brought into service automatically should the main supply fail.

The main power unit comprises a 750 h.p., 440V, synchronous induction motor direct coupled to a 4000kVA alternator, a 2000kW d.c. generator and two exciters. It is connected to the 11kV supply through a 750kVA step-down transformer. The alternator is specially wound to generate at voltages of 11kV, 6·6kV, 5·5kV or 3·3kV, according to the stator connections used. Forced ventilation is employed, the air being drawn from the substation and exhausted through ducts either into the test bay or to the outside atmosphere by a 45in Sirocco fan driven by an 80 h.p. motor.

This power plant has two main functions. First, it can be run as a motor generator for Ward Leonard control of the 2000 h.p. motor in the overspeed test pit or of the driving motor for water-wheel alternators. When so used the alternator is connected to the 11kV supply and operates as a synchronous motor to drive the 2000kW generator, the 750 h.p. motor being used solely for bringing the set up to synchronous speed.

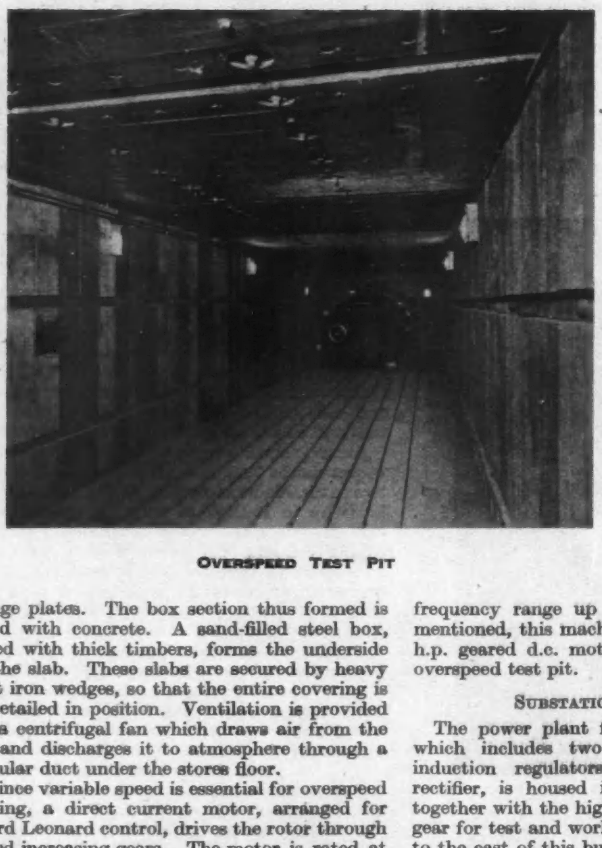
Secondly, the 4000kVA machine may be driven as an alternator for supplying current for ring flux tests of stator cores, and for stator reactance measurements. In both cases the power factor is very low so that the 750 h.p. synchronous induction motor will usually provide a satisfactory drive. If necessary, additional driving power can be obtained by running the d.c. generator as a motor, in which case this machine is connected to the d.c. works supply.

For supplying the excitation current for machines on test, a 360kW, 400V motor generator is installed. The driving motor is of a slip-ring machine rated at 550 h.p., and it operates on the 440V supply. This plant also supplies direct current for heating the rotor windings during the manufacturing process of compressing them in the slots. Provision is made for installing a further motor generator at a future date. This unit will comprise a 4000kVA synchronous machine direct coupled to a 2000kW generator. Either machine can be used for driving, so that the set can provide a d.c. supply or a variable-frequency a.c. supply as required.

A variable-voltage a.c. supply for the 2000 h.p. driving motor on the alternator test bed is obtained from a 2000kVA, 11,000/380V outdoor transformer in conjunction with two motor-operated induction regulators. Each is rated at 500kVA and provides a voltage range from 0V to 760V.

The two outdoor saturable reactors for providing the load on the alternators on test are rated at 75MVA at 22kV and 11kV, or 37MVA at 6·6kV. They can also operate at 100MVA at 15kV on a three-hour rating. Direct current for saturating the reactors is obtained from a 325kW grid-controlled pumpless steel tank rectifier situated in the indoor substation.

In all there are seven transformers, all operating at 11kV, situated in the outdoor substation. The largest of them is rated at 4000kVA for the heavy current a.c. supplies to the test bay. This unit receives power



Overspeed Test Pit

Test Bed for Water-Wheel Alternators

from the 4000kVA alternator of the main motor generator set in the indoor substation. The secondary winding can be connected in star or delta by means of a changeover isolator to give a voltage of 880V or 550V.

Three transformers, two rated at 1000kVA and one at 500kVA, are installed for the 440V distribution system, while a 750kVA unit supplies power to the 750 h.p. driving motor of the main motor generator set. The remaining two units supply the induction regulators and grid-controlled rectifier and are rated at 2000kVA and 600kVA respectively.

The whole of the switchgear in the indoor substation is situated along the north and south walls of the building. An eight-panel metal-clad switchboard, with breakers of 250MVA breaking capacity, controls the two incoming 11kV feeders and the six outgoing feeders to the power transformers. The switchgear is remote operated from a control and metering board in the substation.

For the 440V a.c. distribution system, and for all essential test auxiliaries, an eighteen-panel air-break switchboard is installed. The various panels are in single, double or four-tier form, depending upon the size of circuit breaker and kind of equipment involved. Flat back switchboards are provided for the heavy current a.c. and d.c. supplies to the test beds and core pits, and for the 460V d.c. distribution system. These two boards are in line and mounted adjacent to each other.

Power cables and heavy current busbars in the main erection and test bay are supported from the stanchions at high level. The heavy current busbars are of aluminium strip or channel, depending upon the current capacity. For the 5000A bars, 8in by 3½in channel was chosen because it provides more efficient cooling and reduces skin effect when the bars carry alternating current. The three busbars are arranged in triangular form as illustrated; it will be seen that the lower bar is suspended from a plate which bridges two porcelain insulators and also carries the insulators which support the two upper bars. Slots in the supporting plates and in the busbars allow for any movement due to expansion. The expansion joints consist of aluminium strip formed in packs of eight, with three packs for each busbar. Similar expansion joints are used for busbars made from 4in by ½in aluminium strip. All busbars are painted matt black to assist radiation and thus increase their current-carrying capacity.

For essential house services such as works lighting, office fans and the like, the totally enclosed "plug-in" busbar system is used. The busbars are enclosed in a sheet metal casing with tap-off units at 3ft intervals, and run down each side of the works above the crane walkway.

Site Preparation and Buildings

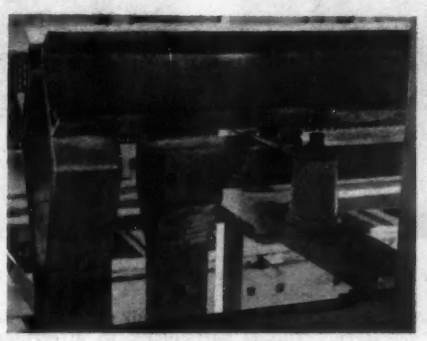
In the preliminary investigations of the site, three test holes revealed hard compressed sand at an average depth of about 12ft with a complete absence of water. According to a geological survey, the hard sand substratum is part of an old river bed, and examination proved it suitable for a loading of 4 tons per square foot. Piling was, therefore, considered unnecessary and concrete blocks, varying from 22ft by 10ft up to 24ft by 12ft and taken to a depth of 14ft, form the foundations for the main stanchions. During the last war, this ground was the site of thirty-four underground air raid shelters. Those shelters interfering with the stanchion foundations were removed completely, the others being broken open, filled and consolidated.

The whole of the overspeed test pit area at the west end of the building was excavated to a depth of 24ft, and the oil tank pit to 30ft. A layer of vegetable soil of poor bearing quality was found about 3½ft below the surface, and was removed over the rest of the area of the main bay and replaced by a filling of pit slag followed by a surfacing of hard core.

The building is a steel-framed and brick-filled structure, with the outer walls faced with Blockley bricks, the disposition of the windows combined with stone features providing ample relief. A riveted and bolted construction has been adopted for the whole of the steelwork. In determining the kind of roof to be used, consideration was given to the natural lighting of the works and to the heat losses. As the building runs due east and west, the cost of a north light roof was prohibitive, and it was finally decided to adopt the ridge roof with three-tier glazing and protected metal sheeting with ¼in fibre board lining. The ground floor is constructed for loadings varying from 2 tons per square foot to 3 tons per square foot in the different sections, the area around the core pits as well as the test section and stores being finished in concrete, whilst wood block flooring is used in the erection and winding sections.

Heating and Ventilation

The heating and ventilating system is designed to maintain a temperature of 65 deg. Fah. in the works with an outside temperature of 32 deg. Fah., when providing one air change per hour in the main bay and first floor of the stores, and one and a half air changes per hour in the rotor and stator coil winding bays, ground floor stores and substation. During the summer the number of air changes can be doubled. The total heating load is over 12½ million B.Th.U. per hour and, in the scheme adopted, full use is made of unit blower heaters so positioned that the hot air outlets are 14ft above the floor. Each heater is supplied with



5000-Ampere Busbars

steam from the low-pressure ring main, the flow being regulated by a motor-operated valve, actuated automatically by thermostats. Alternatively, automatic control can be cut out and remote control substituted. Ducts for the intake of fresh air and for recirculating air from the works are fitted with motor-operated dampers which, together with the two-speed fan motors, are remote controlled from a master switchboard equipped with indicators to show the positions of all dampers. Our illustration of the heating and ventilating plant (p. 628) shows a unit blower on the right and one of the two remote control boards on the left. Further regulation of the rate of air change is provided by extractor fans mounted at high level and arranged for group control from the master control board. To provide supplementary heating and to reduce the effect of the height of the building, a double 3in pipe is run immediately below the vertical glazing on the south side.

Heating trunks are provided at the main doors at the south-east corner and west end of the main bay. Each trunk consists of an axial flow fan and heater, the fan starting up automatically when the door opens, thus providing a blanket of warm air across the opening. During the winter steam is fed continuously to the heaters.

In the offices steam-heated convector radiators with hand-controlled fresh air inlets at low level are used, and will maintain a temperature of 70 deg. Fah. with an outside temperature of 32 deg. Fah. Provision is made for two air changes per hour throughout the year, the air being extracted by "Xpelair" fans. Special arrangements are made for heating and ventilating the lecture theatre. The scheme is designed to provide 15 cubic feet of air per person per hour which represents 5·7 air changes. The heating unit comprises an axial flow fan, heater and filter, installed outside the theatre at the east end and provides the warm fresh air. Foul air is extracted by six "Xpelair" fans mounted at high level. The heater is controlled by a thermostat which governs a motor-operated steam valve. In addition, "convector" radiators are provided for the heating of the fabric itself.

Lighting

Lighting of the main erection and test bay is effected by high-pressure mercury-vapour discharge lamps supplemented by continuous lines of low brightness fluorescent lamps along the sides and ends of the building. The average service illumination is 25 lumens per square foot, and even when the two cranes are operating in tandem for lifting heavy loads the overlap between the high level and tubular lighting is such that immediately below the cranes this figure only drops to 18 lumens per square foot.

Forty-eight 1000W Osram high-pressure mercury-vapour discharge lamps with anodised aluminium reflectors are mounted 70ft above the floor. They are spaced at 30ft centres in three rows 31ft apart, the wiring being so arranged that lamps in adjacent rows are staggered between different phases of the supply in order to minimise any stroboscopic effect. The colour rendering of these lamps is comparable with that of the 400W high-pressure mercury-vapour fluorescent lamps, and their average efficiency is 45 lumens per watt over a life of 3000 hours.

For the side lighting 194 Perspex trough reflectors, each housing two 5ft, 80W fluorescent lamps, are installed in continuous lines round the sides and ends of the bay at a height of 30ft, the reflectors being easily removed for cleaning without disturbing the lamps. The purpose of side lighting is to maintain a high intensity of illumination over the fitters' benches and on the vertical surfaces of machines under construction. In the winding bays, ground floor stores and substation, 400W Osram high-pressure mercury-vapour fluorescent discharge lamps with vitreous enamelled dispersive reflectors are used. Office lighting is provided by 5ft, 80W fluorescent lamps with Perspex reflectors. These natural coloured lamps provide a soft general lighting of the order of 15/20 lumens per square foot, whilst the small amount of upward illumination prevents a dark ceiling.

Public Works at Ghent

Important public works are being carried out at Ghent for the development and the modernisation of the harbour. Two large warehouses for the storage and handling of sawn timber have been built at the "Bassin du Commerce." Both warehouses are prestressed concrete structures, covering an area of 45,000 and 47,000 square feet respectively. In order to give the maximum space for timber handling, the number of interior supports was reduced to a minimum. There are twenty-four columns in the first hangar and only nineteen in the second. The columns are founded on concrete piles.

The most interesting work, however, concerns the restoration of the Port Arthur quay wall, which was in bad condition owing to the dredging operations carried out by the U.S. Army during the war. Sand was removed at a great depth from the toe of this quay wall, which has since lacked stability. A new wharf is now being built, some 46ft in front of the pre-war structure. The quay slab is 3ft thick and 42ft wide. It is founded on four rows of precast piles, 56ft to 75ft long, protected by a steel sheet piling curtain. To give an idea of the magnitude of the work, the following quantities may be mentioned:—Dredging, 390,000 cubic yards; earth filling, 325,000 cubic yards; steel sheet piling, 6000 tons; reinforced concrete piles, 4400 piles; reinforced concrete, 39,000 cubic yards.

Mobile Television Outside-Broadcast Stations for Canada

THE photographs reproduced herewith illustrate two special vehicles which form part of a large contract by Marconi's Wireless Telegraph Company, Ltd., to provide a complete television system for Canada. Each vehicle is a self-contained three-camera television station, complete with its own production and transmission equipment, which can be driven to any place within microwave range of the main station or re-transmission point and, with a trained crew, can be "on the air" in forty-five minutes.

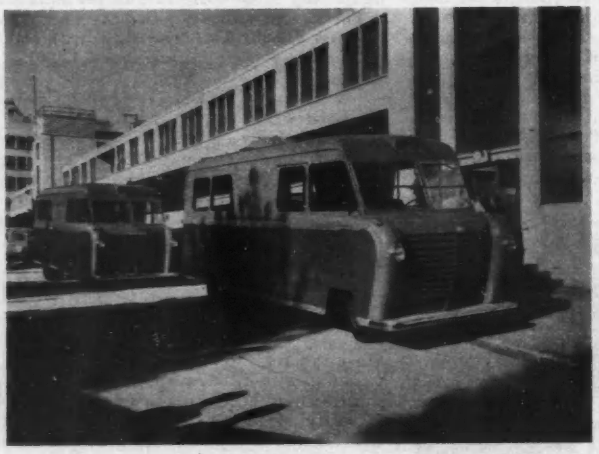
The interior view of the vehicles shows the general arrangement of the apparatus. In the foreground are the store cupboards, on the left, and the power regulating unit on the right. On the main desk are mounted the broadcast distribution box, three camera control monitors, the master control monitor, and mixing unit. Above the desk are the sound receiver and "on the air"-vision receiver. On the extreme right is the producer's desk. Each of the three cameras is carried in a fitted cupboard together with the associated electronic viewfinders and sets of lenses.

With the operational facilities provided in these vehicles all members of the crew can hear, in their earphones, programmes as well as instructions. Camera operators can speak to camera control personnel and producer; the producer and technical director can speak to each member of the crew.

The chassis, as illustrated, is a Chevrolet, fitted with a 105 b.h.p. "Roadmaster" engine, but all the bodywork, fittings and equipment are, we learn, British. The microwave link is stowed permanently on the roof of the vehicle. An internal ladder gives access to the roof, where the engineer can erect and orientate the parabola. Reels at the back of the vehicle carry the cable and the receiving aerial is mounted on outriggers.

The only external requirements of these mobile stations are the connections to electricity mains and telephone, but it should be pointed out that the Marconi Company could, if required, eliminate those requirements by using a trailer generator power supply instead of the mains and a microwave sound channel instead of the telephone lines. In the Canadian equipments as supplied, mains supplies ranging from 90V to 240V can be used. Interior lighting is operated both by mains and by battery and there is a mains-operated battery charger. To allow for night parking of the vehicles away from a mains supply oil heating is provided.

Both vehicles are finished in grey-blue upper bodywork with "Traffic" blue lower bodywork and aluminium trim bands and chromium-plated fittings. All the side windows are double glazed and the interior panelling is in "Birdseye Maple" and "Cherry Mahogany" plastic, with upholstery in calf leather cloth on "Dunlopillo." There are special front and rear exterior lights to conform with Canadian traffic regulations and there is a swivel-working light at the rear of each vehicle.

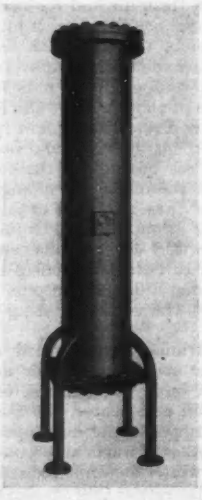


TELEVISION OUTSIDE-BROADCAST VEHICLES

INTERIOR OF VEHICLE

Catalytic Gas Purifier

RECENTLY, Baker Platinum, Ltd., of Holborn, London, displayed some of the units of a new process named "Deoxo" which has been developed by Baker and Co., Inc., U.S.A. The process has been devised to provide a simple, efficient and trouble-free method of removing unwanted oxygen or hydrogen from industrial gases by use of a catalyst. There are many industrial processes which at some stage make use of gases which must be virtually free from oxygen, so that some method of reducing the oxygen content to a very small percentage is necessary. This is particularly so in certain metallurgical operations such as bright annealing, in the manufacture of powder metals and in a number of chemical processes such as the synthesis of ammonia. Commercial quality hydrogen or nitrogen contains a certain amount of oxygen, generally up to 0·3 per cent, but sometimes in excess of this percentage, and even the presence of this relatively small quantity can cause difficulties and even prove harmful under certain circumstances. In the "Deoxo" process the gas is passed through a purifier at room temperature, after which any impurities remaining are less than one part in a million. The removal of the oxygen impurity from hydrogen or from other inert gases is achieved by passing the gas over a specially prepared catalyst, which causes hydrogen and oxygen to combine in the ratio of two to one by volume. This reaction takes place at room temperature and the water vapour which is formed is carried away in the gas stream and then removed by a dehydrator. A certain amount of heat is generated by the catalytic reaction, the rise in temperature being approximately 18 deg. Fah. for each 0·1 per cent of oxygen removed. From the nature of the reaction it is evident that impurities of oxygen or hydrogen can be removed from inert gases such as nitrogen, argon, helium, neon, carbon dioxide and saturated hydro-carbons provided that oxygen and hydrogen are present, in the gases to be treated, in the ratio of two volumes of hydrogen to one volume of oxygen. In the event of one or the other of the gases not being present in a free state, then the necessary volume required to effect the formation of water vapour must be added to the gas stream before it passes through the purifier.

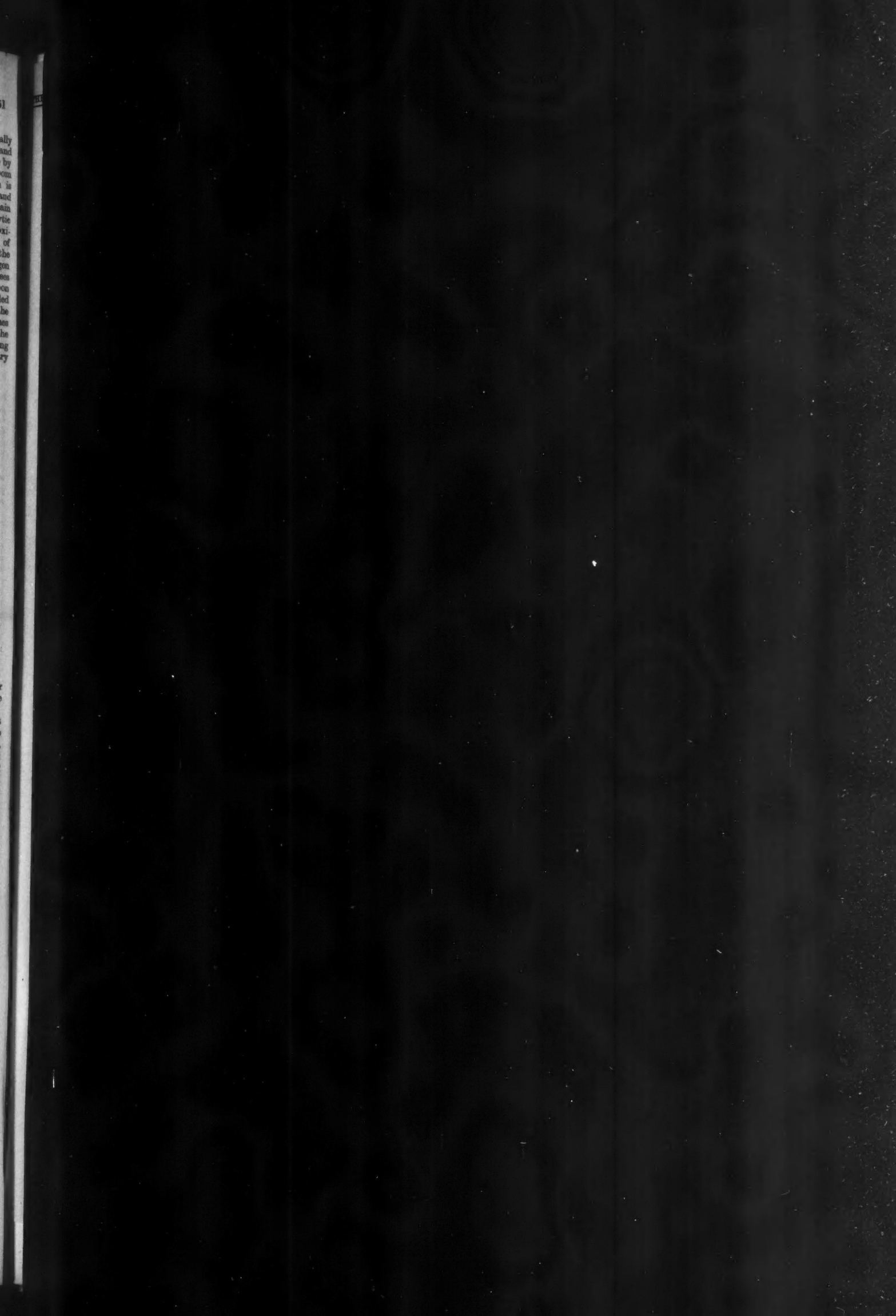


CATALYTIC GAS PURIFIER

The standard equipment will operate at pressures up to a maximum of 50 lb per square inch and the units available are in five sizes, which have flow rates of 5, 200, 1000, 2500, and 5000 cubic feet per hour, the corresponding weight being 8 oz, 50 lb, 170 lb, 350 lb, and 490 lb respectively. It is claimed that the Baker "Deoxo" units, which are of compact and rugged construction, cost nothing to operate, since no electrical current is used, no auxiliary heating is required, no cooling water is needed, and there are no maintenance expenses. The unit, once it is introduced into the gas supply line, will continue to operate indefinitely without attention.

The company expects to introduce additional units for wider application and the research department is developing processes to provide for the catalytic combination of oxygen and hydrogen in the presence of carbon monoxide; oxygen and carbon monoxide to form carbon dioxide in gases which do not contain hydrogen; carbon monoxide in hydrogen to form carbon dioxide, and carbon monoxide and hydrogen to form methane and water vapour.

COLLIERY LUBRICATION.—To the very useful range of books on lubrication in the technical series issued by C. C. Wakefield and Co., Ltd., 46, Grosvenor Street, London, W.1, there has now been added a new publication, *Colliery Lubrication*. This book deals in turn with each of the principal groups of machinery used in collieries and briefly describes their construction and operation with particular emphasis on their care and lubrication. The descriptive matter is well illustrated with photographs and drawings. This publication will be a useful guide to lubrication for all concerned with colliery equipment, and students in particular will find it a very handy source of information on lubrication and maintenance. It is issued free of charge upon application to the firm at the above address.



Roller Bearing Axleboxes on the Standard Locomotives

...ived from British Timken, Ltd., Northampton, some interesting ...roller bearing cannon boxes and ... the company has supplied for ...motives being built under the ... of British Railways. All of ...ass 7, ten of the Class 6, thirty ...motives, and twenty of the ...tenders are fitted with the ...

...7, 6 and 5 locomotives one ... of bogie is used, and these ... with the solid, as distinct from ... illustrated below. These ... two tapered roller bearings, ... and having a bore of 6in ... diameter of 10in. Each ... of a simple one-piece cast ... in which positive ... as well as stability ... ...ntained under all condi... ...ured by bolts at each end of ... arranged that, on ru... ...y can be axially displa... ...inspection to be carr... ...f covers also incorpora... ...enclosure sleeve, wh... ...a finger mounted on the ...rubbing seal against ... of ...irt and moisture. ... two seals per cannon box ...y are located adjacent to the ...using has a large oil ...

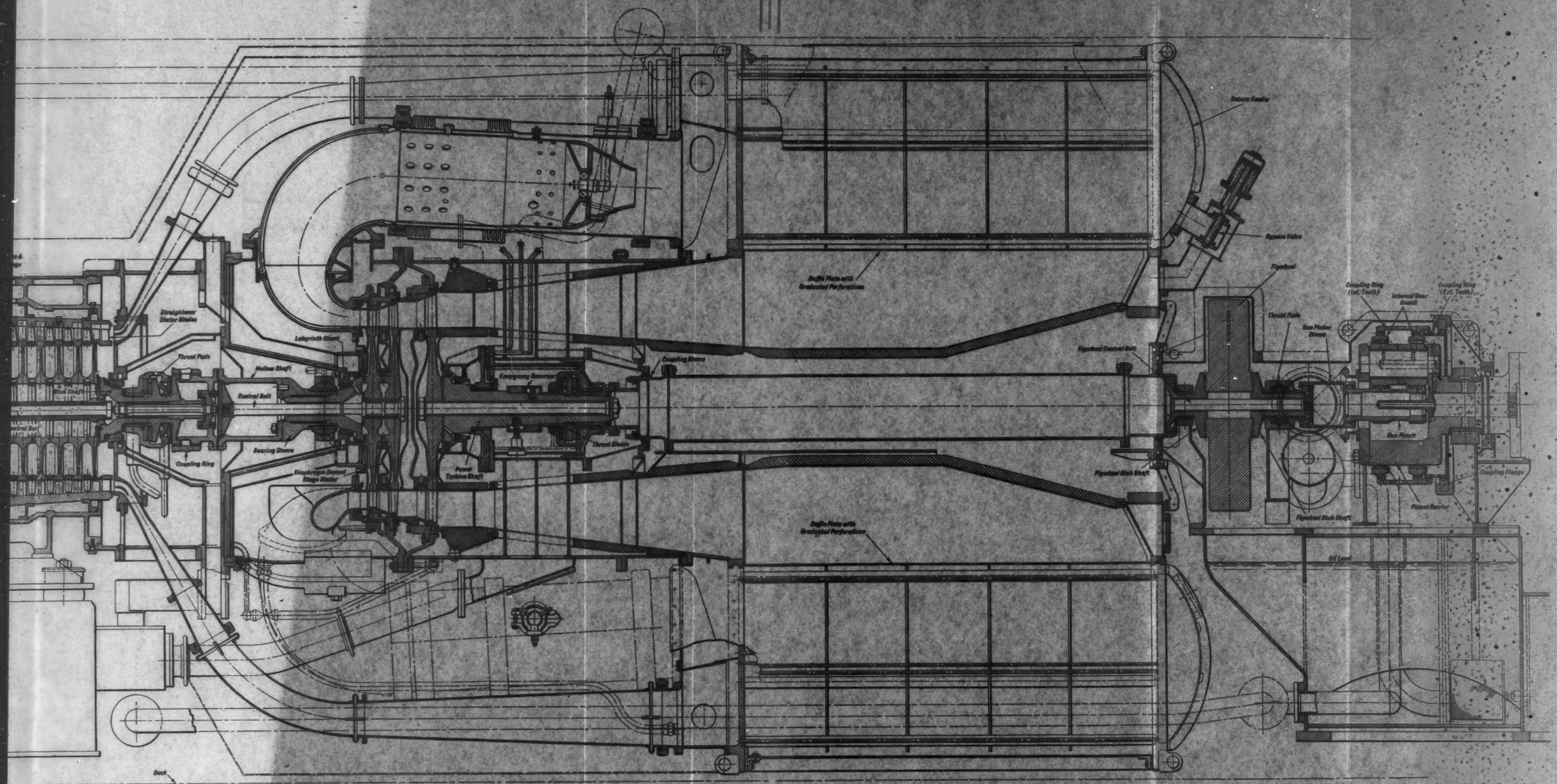
The weight of the ... bogie box complete with bearings is ... cwt.

For the ... ...s only two ... journal ... ... bore ... ... Class 7 ... ... 10½in ... ... driving ... ... This ... ...

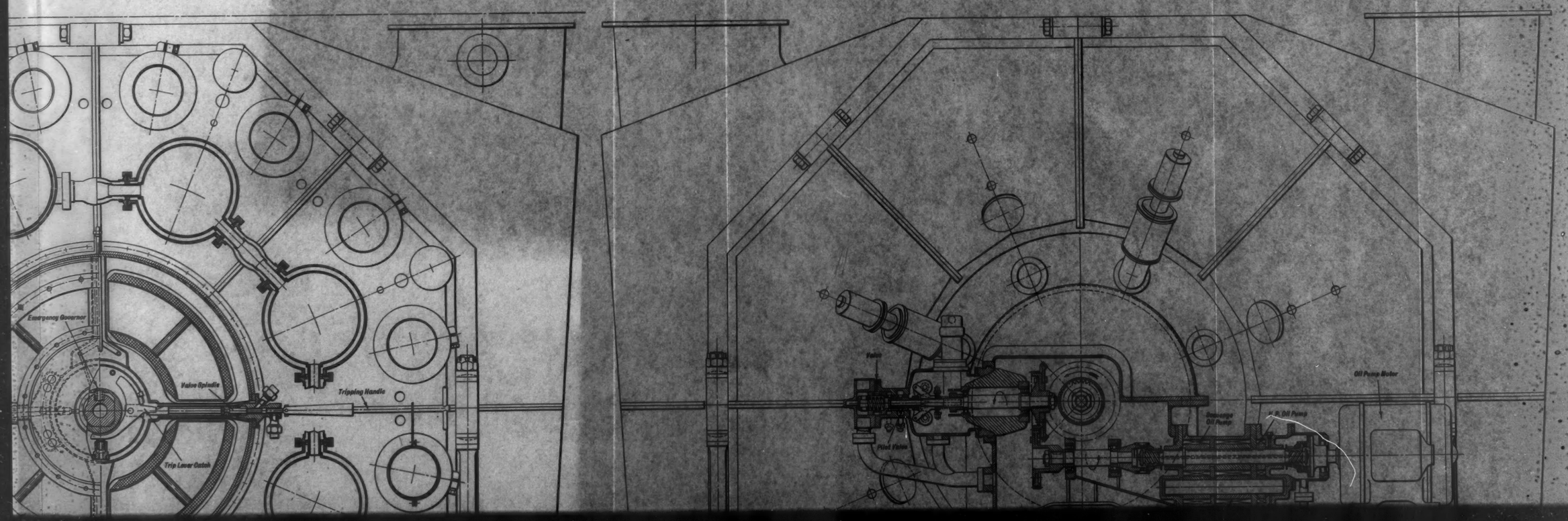
...so that ... ...

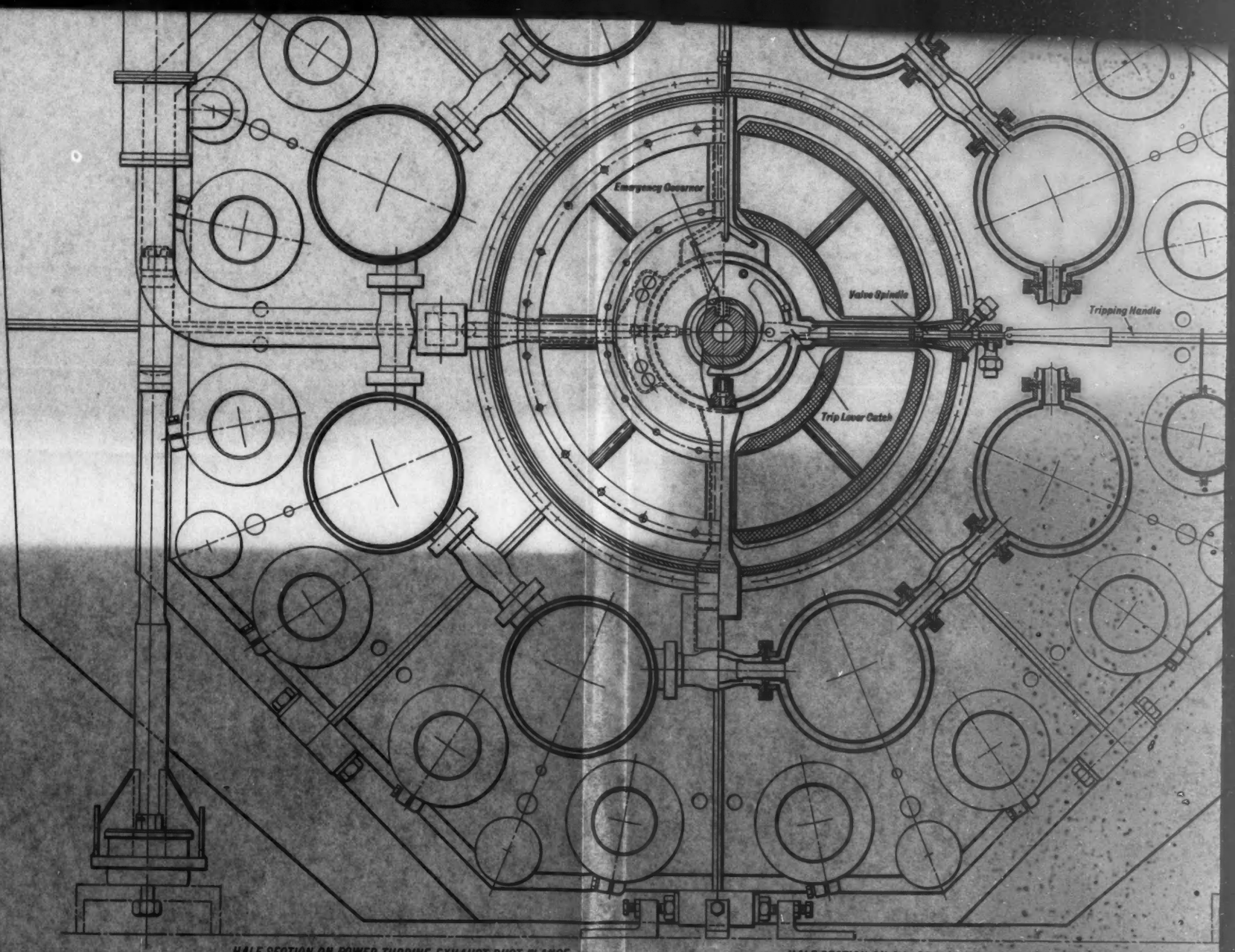
1000kW MARINE GAS TURBINE

W. H. ALLEN, SONS AND CO., LTD., DESIGNERS AND MAKERS



LONGITUDINAL SECTION

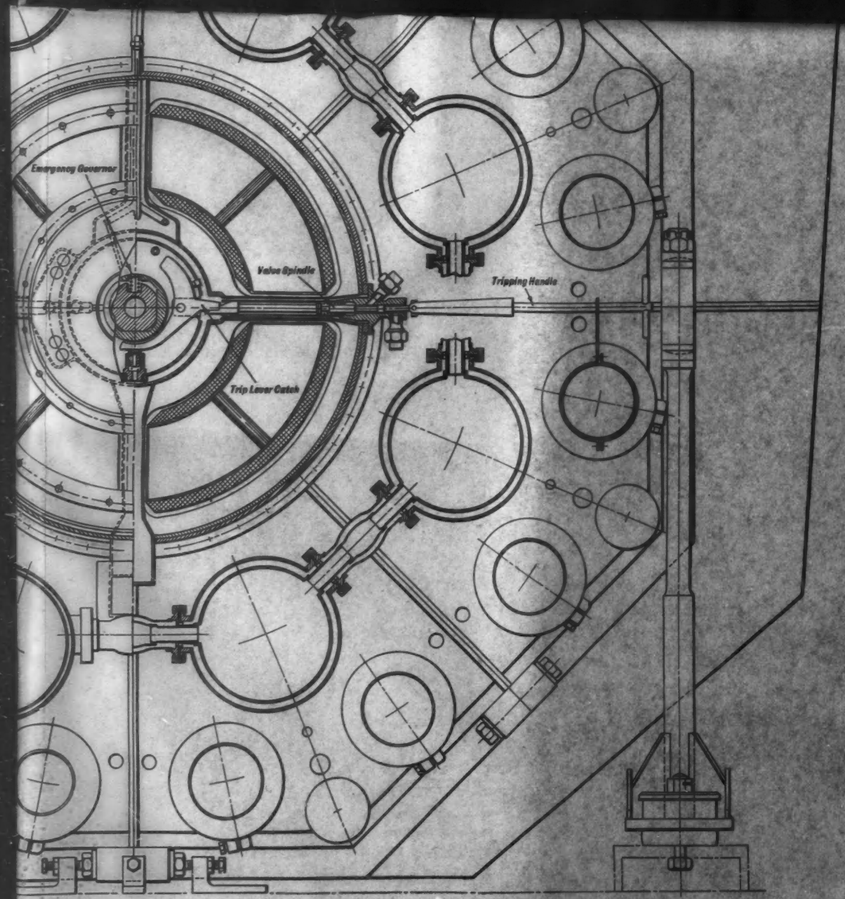




HALF SECTION ON POWER TURBINE EXHAUST DUCT FLANGE.

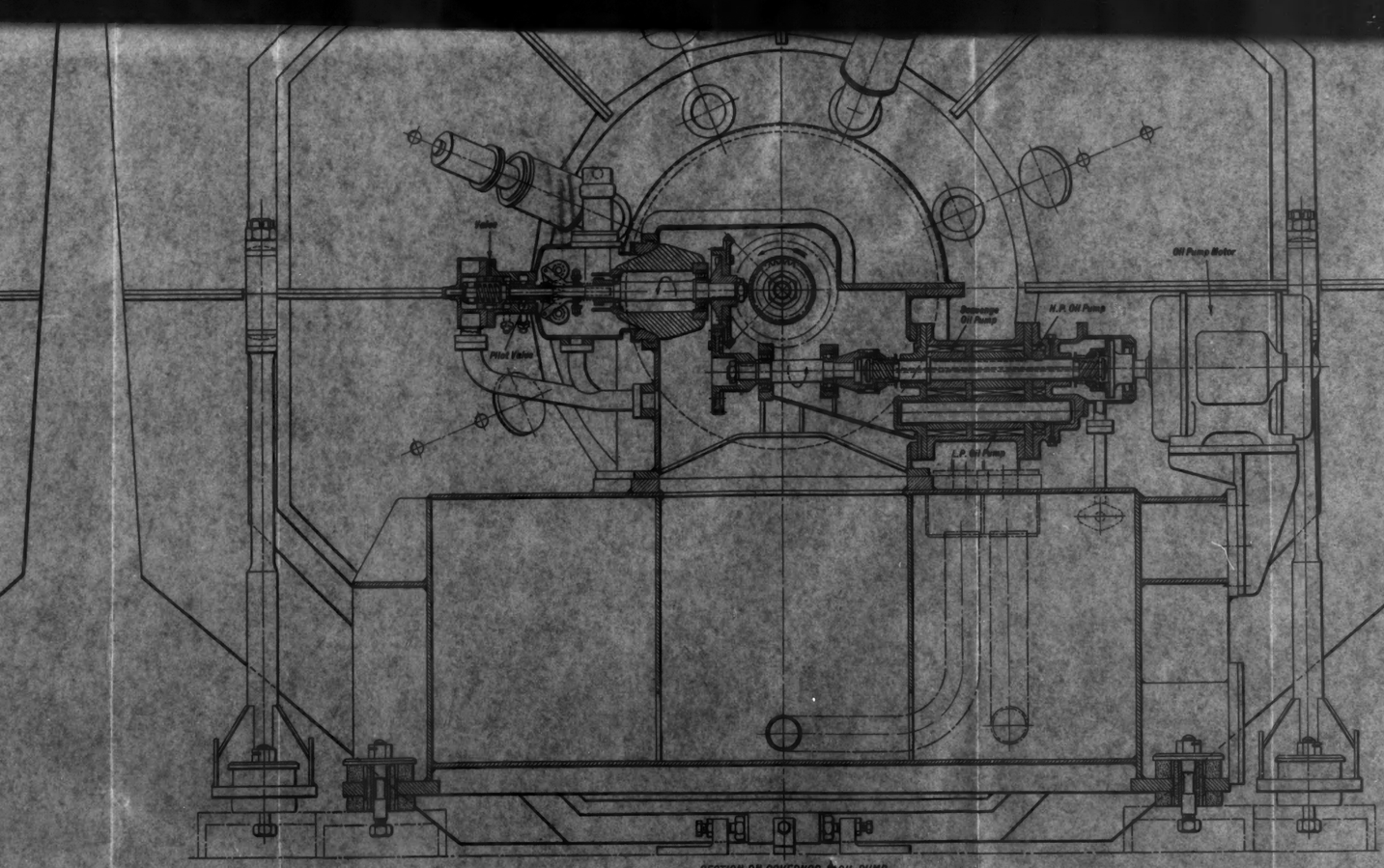
HALF SECTION ON C.L. OF INTERCONNECTORS & POWER TURBINE EMERGENCY

VIEW LOOKING FROM COMPRESSOR END.



HALF SECTION ON C.L. OF INTERCONNECTORS & POWER TURBINE EMERGENCY TRIP.

VIEW LOOKING FROM COMPRESSOR END.



SECTION OR GOVERNOR & OIL PUMP.

VIEW LOOKING FROM ALTERNATOR END.

0 1 2 3

Scale Feet

Roller Bearing Axleboxes on the Standard Locomotives

WE have received from British Timken, Ltd., of Duston, Northampton, some interesting notes on the roller bearing cannon boxes and axleboxes which the company has supplied for the standard locomotives being built under the 1951 programme of British Railways. All of the twenty-five Class 7, ten of the Class 6, thirty of the Class 5 locomotives, and twenty of the Class 4 locomotive tenders are fitted with the firm's axleboxes.

On the Class 7, 6 and 5 locomotives one common design of bogie is used, and these bogies are fitted with the solid, as distinct from split, cannon boxes illustrated below. These boxes are fitted with two tapered roller bearings, one at each journal, and having a bore of 6in with an outside diameter of 10in. Each cannon box consists of a simple one-piece cast steel tubular housing in which positive alignment of the bearings as well as stability of the axle assembly is maintained under all conditions. Split covers are secured by bolts at each end of the housing, and so arranged that, on removal, the cannon box body can be axially displaced to enable bearing inspection to be carried out. These split end covers also incorporate an aluminium bronze enclosure sleeve, which, in conjunction with a flinger mounted on the axle, forms a non-rubbing seal against loss of oil and ingress of dirt and moisture.

There are only two seals per cannon box assembly and they are located adjacent to the wheel hub. The housing has a large oil reservoir at each end to ensure adequate bearing lubrication, and cored slots in the casting permit automatic circulation of the oil set up by the tapered construction of the bearings. The guide faces of the cannon boxes are fitted with manganese steel liners. A combined breather and condensing vent is mounted on the tubular portion of the housing.

The tapered construction of the Timken bearing, designd to combine the advantages of true rolling motion and full-line contact with both inner and outer races, permits the handling of any combination of radial and thrust loads imposed by the bogie frame structure and the wheel set. The inner races of the bearings are a press fit on the axle and take their abutment through a ring on to the axle shoulder. The outer races are a close fit in the bore of the housing and correct bearing end play is regulated at assembly by split adjustment rings located behind the end covers. Two machined faces are provided on the tubular portion of the housing, to which A.T.C. brackets may be secured by means of studs and also located by a keyway.

The weight of one cannon bogie box complete with bearings is 5¼ cwt.

For the Class 7, 6 and 5 locomotives only two journal diameters for the coupled axles have been used. The main driving axle of the Class 7 locomotive has a journal diameter of 10½in and the leading and trailing coupled driving axles have a journal diameter of 9½in. This journal diameter also applies to all driving axles on the Class 6 and Class 5 locomotives, so that only two bearing sizes and two basic designs of cannon boxes are used on all driving and coupled axles of the three classes of locomotives.

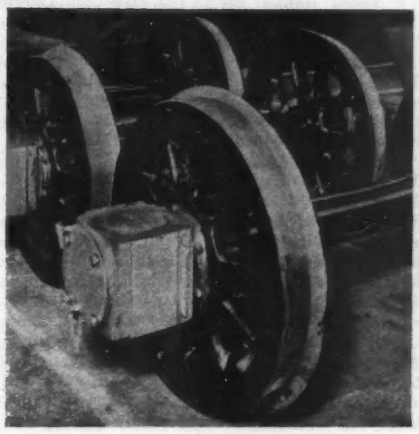
The design of these driving cannon boxes, one of which is illustrated, is generally as for the leading bogie cannon boxes. They consist of one-piece cast steel tubular housings, each equipped with two Timken bearings, one at each journal. All bearing cones are a press fit on the axle and take their abutment through a ring on to the axle shoulder.

The tubular housing incorporates at each end an annular rib, which is used when it is required to remove the bearing from the axle. Displacement of the axle longitudinally in the housing brings the inner race or cone of the bearing into contact with the machined rib. By supporting the housing and applying axial pressure to the axle it is pushed through the inner bearing race, which is thereby removed from the axle.

The weight of the complete Class 7 main driving axle cannon boxes is 12¼ cwt and the weight of the leading and trailing axle cannon boxes is 11 cwt. The Class 6 and 5 driving, leading and trailing cannon boxes also weigh 11 cwt each.

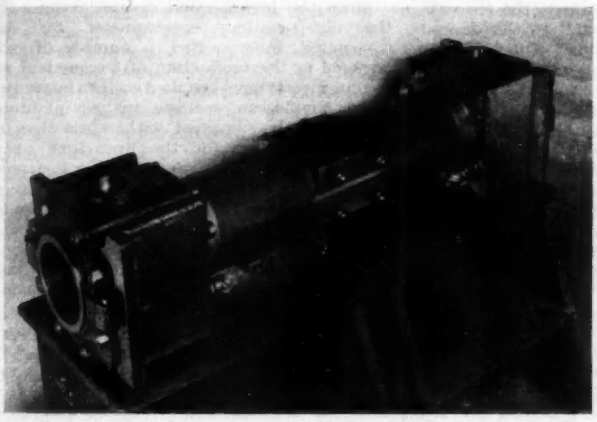
The same design of outside journal axlebox is used on the trailing truck of the Class 7 and 6 locomotives as on the tenders of the Class 7, 6 and 5 engines. These axleboxes, which are one-piece steel castings, are each fitted with two Timken bearings separated by spacers and mounted with the large ends of the rollers pointing outwards. This arrangement of mounting combined with the wide bearing spread gives a high resistance to tilting moments, such as those set up under off-centre loading conditions.

Following normal railway practice used in mounting wheels, the bearing inner races are a press fit on the axle. Correct initial end play of the bearings is obtained at the factory by spacer adjustment, and the axlebox complete with bearings is finally pressed on to the journal as a complete unit and secured by a locknut. The bearing outer races are a close fit in the bore of the axlebox body. A combined breather and condensing vent are incorporated in the front inspection plate of the box and the non-rubbing seal is incorporated in the cast steel back cover. Inspection of the bearings can be carried out by removing the back cover securing nuts and withdrawing the axlebox body from the bearings, which are left undisturbed on the axle. The bearings fitted to these axleboxes are interchangeable with those fitted to the leading bogie cannon boxes.

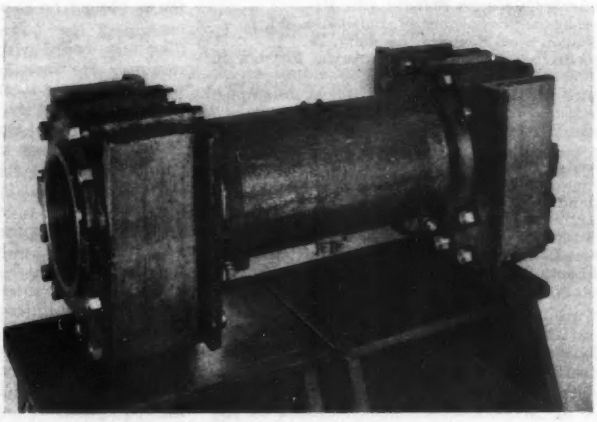


TRAILING TRUCK AND TENDER AXLEBOXES

The tender axleboxes for the Class 4 locomotives follow the firm's standard design of outside journal axlebox for centrally applied loads. These axleboxes are fitted with a dual inner race bearing pressed directly on the axle, and they do not require any retaining device, such as locknuts. The axlebox body design is generally similar to that for the larger Class 7, 6 and 5 locomotives, and is also arranged so that the axlebox and bearing is mounted on the axle as a complete unit.



BOGIE CANNON BOX



DRIVING AXLE CANNON BOX

A NEW CENTRIFUGAL DRYER.—To supplement its two sizes of electrically heated centrifugal dryers, W. Canning and Co., Ltd., of Birmingham, 18, has now introduced a larger capacity machine, which will deal with a load of 7 to 8 gallons of small articles. With this new machine the work basket does not have to be lifted out as it is arranged for bottom discharge of the dried articles into a suitable container placed beneath. It is designed to reduce handling and with it large quantities of small mass-produced parts can be dried rapidly and effectively without damage. A safety device prevents the basket being set in motion until the lid is closed and the lid from being opened whilst the basket is still revolving. Totally enclosed heating elements function at full capacity only while the machine is actually running, two-thirds of the heating capacity being automatically switched off when the machine is idle during loading and unloading.

The World Metallurgical Congress and 1951 National Metal Exposition

(By our American Correspondent)

"PRODUCTION for Defence" was a timely theme to have been chosen for the Thirty-Third National Metal Congress and Exposition, which was held in Detroit, Michigan, during October. As in previous years, it was sponsored by the American Society for Metals, the American Welding Society, the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers, and the Society for Non-Destructive Testing. This year's meetings were of particularly international interest, as the First World Metallurgical Congress, sponsored by the American Society for Metals, took place simultaneously with the "Metal Show" in Detroit. Thanks to the backing extended by the Technical Assistance Division of the Economic Co-operation Administration, several hundred engineers and metallurgists from almost thirty nations, including some fifty from the United Kingdom, were enabled to spend about six weeks in the United States, and, through the co-operation of American industry, plant visits and inspections were arranged for them as a preliminary to attending the actual Congress. In accordance with the respective interests of the foreign conferees, eleven different plant visit itineraries were arranged, and it is perhaps of interest here to list the works and laboratories visited by the group concerned with "Steelmaking and Refining." :—

Research Laboratory of the U.S. Steel Company, Kearny, N.J.
Crucible Steel Company of America, Syracuse, N.Y.
Midvale Company, Philadelphia, Pa.
Bethlehem Steel Company, Baltimore, Md.
Lebanon Steel Foundry, Lebanon, Pa.
Crucible Steel Company of America, Pittsburgh, Pa.
Jones and Laughlin Steel Company, Aliquippa, Pa.
Irvin Works of U.S. Steel Company, Pittsburgh, Pa.
Weirton Steel Company, Weirton, W. Va.
Armco Steel Corporation, Middletown, Ohio.
Inland Steel Company, Chicago, Ill.
Gary Works of U.S. Steel Company, Gary, Ind.
Ford Motor Company, Detroit, Michigan.
Great Lakes Steel Corporation, Detroit, Mich.
McLouth Steel Company, Detroit, Mich.
Rotary Electric Steel Company, Detroit, Mich.

The National Metal Exposition

More than 400 companies engaged in the production, treatment and fabrication of metals exhibited in seven buildings with a total floor space of 287,000 square feet, situated at the Michigan State Fair Grounds on the outskirts of Detroit. One of the more decided trends in the metallurgical field to be observed at the exhibition is the growing popularity of the low-hydrogen welding electrode in the United States. Typical of the low-hydrogen ferritic electrode range offered by American manufacturers is the "Tensilend" series of the Arcos Corporation, a mild steel electrode equivalent to AWS Class E7016 for the welding of high-tensile low-alloy steels; a nickel-molybdenum-vanadium electrode equivalent to AWS Class E10016 for the welding of high-yield notch-tough structural steels; and a nickel-molybdenum-vanadium electrode equivalent to AWS Class E12015 for the welding of high-tensile armour plate.

To deal with the heavy demands of armour plate welding, several new a.c. transformer welding sets have been developed in the past year, and the new 400A and 500A, 80V "Flex-arc" units shown by the Westinghouse Electric Corporation are representative of this trend. These sets are equipped with an automatic voltage reducing control, which reduces the open-circuit voltage from 80V to 30V during idling periods. The primary capacitors incorporated in the units raise the primary power factor to approximately 80 per cent at rated load. When idling, all but one of the capacitors are disconnected automatically. The remaining capacitor furnishes the excitation kVA of the transformer.

To meet the continuously increasing demand for inert gas shielded arc welding equipment, the General Electric Company has developed a new series of a.c. inert-arc welding sets having ratings of 200A, 400A and 800A respectively. These units are self-contained and have a high-frequency pilot spark for arc starting and automatic control of cooling water and shielding gas. The company also introduced an interesting new semi-automatic inert-arc welding set known as "Fillerweld," which operates on the principle of a non-consumable electrode. The equipment consists of two main elements: a gun and a mechanical power unit. It is used in conjunction with either the a.c. inert-arc welding set described above or a standard d.c. welding unit. The gun is basically a manual, water-cooled, inert-arc tungsten holder, to which has been added a control switch and a gear assembly for pulling the filler metal through the gun. Rated at 250A, the gun has been designed to take tungsten electrodes 0·040in, $\frac{1}{16}$in, $\frac{3}{32}$in, $\frac{1}{8}$in, and $\frac{5}{32}$in in diameter, and up to 7in long, and 0·040in diameter filler wire. The mechanical power unit consists of a motor which provides power for drawing the filler metal, a "Thy-mo-trol" unit for controlling the motor speed, and a spindle for holding the reel of filler wire, all mounted on a portable carriage. The motor operates on 220V, single-phase, 60 c/s supply. In setting up the unit for welding, the operator adjusts the rheostat on top of the "Thy-mo-trol" to the desired filler wire speed within a range of 0–250in per minute. He then holds the gun just as if it were a standard inert-arc torch, and strikes the arc. As soon as the molten pool is established on the base metal the operator pulls the trigger and the wire feeds into the arc. The operator can easily adjust the speed so that filler wire melts evenly into the pool without stubbing on the work. An on-off trigger switch on the handle of the gun gives the operator convenient control of the feed of filler metal. The "Fillerweld" equipment is primarily intended for the inert-arc welding of aluminium, magnesium, stainless steel, copper and Inconel in thicknesses up to $\frac{1}{16}$in., with either argon or helium gas being used.

Another company has now started manufacturing automatic submerged-arc welding equipment in America. Shown for the first time, the "944" welding head of the Mir-O-Col Alloy Company, of Los Angeles, has a wire nozzle with a current capacity of 2000A and hardened steel wire feed rolls able to accommodate any electrode size from $\frac{1}{16}$in to $\frac{1}{4}$in in diameter. The head is used in conjunction with an a.c. transformer welding set, which includes a high-frequency section for the starting and the stabilisation of the arc. The rate of feed of the electrode wire is determined by the arc voltage through an electro-mechanical control circuit. Bare wire is used, and conventional welding flux is fed to the point of deposit through a gravity hopper system.

The elimination of flux or ceramic ferrules is one of the more interesting aspects of a new stored-energy stud welding system, which was exhibited for the first time at the "Metal Show" by the Graham Manufacturing Corporation. The system is based on the utilisation of a capacitor welding control, of studs which require no flux, and of an automatic hammer blow which forces the two molten surfaces to be welded together. In principle, the process may best be explained by considering the flow of current through the welding circuit. After the condensers are charged the current flows through the gun and the collet to the stud, which is at this time travelling toward the workpiece at a predetermined velocity. The positive side of the condenser is connected to the work table and hence to the workpiece. The stud has a small cylindrical tip, which is situated centrally on its base and which is an integral part of the stud. As the stud travels downward this tip is the first to approach and touch the work area. At this time the discharge is initially concentrated at the tip. The concentration of current at this small tip causes overheating, and the tip burns or explodes. This heat causes ionisation around the tip, and an arc forms from the face of the stud to the workpiece. As a result the face of the stud, and a like area on the workpiece, becomes molten. The stud then meets the workpiece at a velocity of about 31in per second, and the hammer blow from the inertia of the moving piston, piston-rod and collet assembly forces the two parts to be welded together. The Graham portable stud welder comprises eight condensers, each having a capacity of 38,000 microfarad at 100V and requires a work area of only 20in by 20in. Due to the use of a capacitor welding control, it is possible to weld studs of most ferrous and non-ferrous metals and alloys with this set.

A remarkable development in the field of non-destructive testing is the growing acceptance by American industry of the Betatron. Two models were exhibited: a 24MeV unit made by the Allis-Chalmers Manufacturing Company, capable of dealing with steel sections up to 24in thick, and a 15MeV General Electric set, able to penetrate steel sections up to 14in in thickness. Both machines have a focal spot size of only 0·005in and claim a sensitivity of 0·3 per cent. The Sperry "Ultrasonic Reflectoscope," another tool available for non-destructive testing purposes, is also finding increasing use in American industry, and the company's display stressed its application in the inspection of fabricated high-temperature and high-pressure pipework.

Since the introduction several years ago of the direct-reading spectrometer by Baird Associates, Incorporated, a number of works engaged in the production of ferrous and non-ferrous metals have installed such an instrument, which enables an accurate analysis of furnace samples to be obtained within less than five minutes. Shown for the first time at the National Metal Exposition, another instrument of this kind has now been developed by the Applied Research Laboratories, of Glendale, California. This "Production Control Quantometer" consists of a spectrometer and a recording console and allows a direct-recorded chart, showing the analysis of a melt, to be obtained at the rate of 2·4 seconds per element. The spectrometer covers the range of wavelengths from 2000Å to 8000Å and is furnished with a concave grating having a ruled area 1in long, 2in wide, with 24,400 lines to the inch. It is claimed that standard deviations on chromium and nickel contents in stainless steels, for example, are less than 0·5 per cent of the amount actually present.

In line with the development of the direct-reading and the direct-recording spectrometer, there has recently been much interest in rapid and precise methods of carbon analysis of iron and steel of low-carbon content (below 0·10 per cent). Low-carbon ferro-chromium, stainless steel, high-silicon transformer steel, and ingot iron have been the principal alloys requiring analysis. While low-pressure methods are available for extremely precise measurement, they have the disadvantage of requiring complicated and expensive equipment and, in general, require twenty to sixty minutes for a single determination. The Laboratory Equipment Corporation, of St. Joseph, Michigan, has now developed a carbon determination method requiring only five to ten minutes' analysis time for most iron alloys, and the results are said to compare favourably with the low-pressure method. The instrument has a range of 0–0·35 per cent carbon, based on a 1 gramme sample, and a sensitivity of about 0·0002 per cent, depending upon the strength of the solution used. The carbon content is found in the following manner. A sample is burnt in oxygen in a conventional resistance or high-

frequency induction furnace, and the amount of carbon dioxide resulting is established by measuring the change in conductivity of a barium hydroxide solution through which the CO_2 is passed. The apparatus consists of a Wheatstone bridge, a sulphur trap through which the products of combustion are passed, the barium hydoxide measuring cell for the carbon dioxide and excess oxygen, and a cathode ray tube. The change of resistance in the measuring cell is plotted against the known carbon content of the sample on a graph. The graph is a straight line over the range 0–0·035 per cent carbon, and is then used in ascertaining the carbon content of unknown samples.

An interesting range of thickness gauges making use of beta radiation was exhibited by Tracerlab, Incorporated, of Cambridge, Massachusetts. The company's absorption beta gauge is used to measure and indicate continuously deviations in the thickness of sheet material—paper, plastics, rubber, thin metal sheets, coatings, &c.—by means of a small beam of beta rays. These rays are emitted by a sealed radio-active source and pass through the sheet to be measured. Variations in sheet thickness increase or decrease the number of electrons absorbed in the material before entering the detecting head. Every change brings about a corresponding change in the electrical current flowing to the meter and sheet deviations are thus easily measured. The gauge consists of four basic elements: a source of beta radiation, an ionisation chamber to detect and convert beta radiation to electrical current, a pre-amplifier to boost this current to measurable levels, and a meter to indicate fluctuations in this current.

Another beta gauge, known as the backscatter gauge, measures from one side only the thickness of coatings on many kinds of base materials, or the thickness of sheets passing over a calender roll or other backing surface. Essentially the same as the absorption unit, the major difference in the backscatter gauge is that the radiation source is situated on the same side of the material as the ionisation chamber. This source is shielded to make certain that only backscattered radiation reaches the chamber. Thus, when sheet material is placed in the measuring position the ionisation chamber picks up diffusely reflected beta rays and the resulting chamber current determines the meter reading. Because the detecting unit and the source are integrated, the backscatter gauge offers advantages for scanning installations where material thickness across the entire width of a sheet must be gauged. This feature also makes it possible to use the gauge for installations where it is inconvenient or impossible to reach both sides of a sheet of material.

The initial public showing of the "Method X" machine for the accurate machining of sintered carbides and similar "hard-to-cut" metals took place during the "Metal Show" at the booth of the Firth Sterling Steel and Carbide Corporation, of Pittsburgh, Pennsylvania. The metal removal brought about by this machine is a mechanical, not thermal, effect of high-density electrical current. A shaped electrode descends into the workpiece, "bombarding" the adjacent surfaces with controlled spark discharges. This action causes the metal particles to dislodge and float away swiftly in the surrounding dielectric fluid. The metal particles detach themselves without melting, leaving the exposed surfaces physically and chemically unchanged. The design of the machine is similar to that of a drilling machine. It has a pedestal base, an electrode feed and control mechanism, and a remote power supply. The longitudinal, lateral and vertical traverse of the work table provide flexibility for work alignment. The electrode feed is automatically controlled to maintain optimum cutting speeds under all conditions. The cutting operation is submerged in a dielectric fluid, such as fuel oil or kerosene. The fluid carries away the dislodged metal particles from the work surface. The electrodes are made of a highly conductive, easily machined material, such as brass. When the machining operation can be performed with the head moving in a vertical direction the electrodes are usually formed to represent a negative of the shape to be produced. Difficult internal, irregular contours, situated some distance below the top of the workpiece, can be formed by the use of certain electrode adaptations. It is claimed that precision machining operations can be controlled to an accuracy of 0·0005in. Surface finishes of 26 micro-inches (r.m.s.) are said to be possible and lapping of less than 0·001in has produced a finish of 0·15 micro-inch on sintered carbide.

Congress Proceedings

All papers contributed to the Congress are being published in a bound volume as the *Proceedings of the World Metallurgical Congress* by the American Society for Metals. Among the British contributions were a paper on "Phosphorus Deoxidation of Molten Copper," by W. A. Baker, Research Manager of the British Non-Ferrous Metals Research Association; a paper dealing with "Phase Changes Associated with Sigma Formation in 18–8–3–1 Chromium - Nickel - Molybdenum - Titanium Steel," by K. W. Bowen and T. P. Hoar, of the Department of Metallurgy, University of Cambridge; a paper on "The Mechanical Properties of Iron and Some Iron Alloys of High Purity," by W. P. Rees, Senior Principal Scientific Officer of the National Physical Laboratory, Teddington, Middlesex; and a paper entitled "Elimination of Yield Point Phenomena by Temper Rolling and Roller Levelling," by N. H. Polakowski, of University College, Swansea.

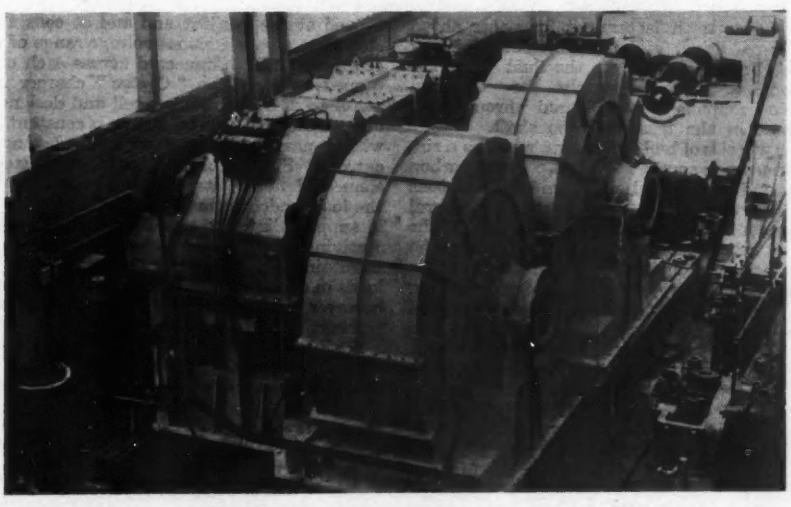
The 1951 awards of the American Society for Metals were presented at the annual dinner of the Society in Detroit. The Sauveur Achievement Award was presented to Dr. Robert F. Mehl, Head of the Department of Metallurgy, Carnegie Institute of Technology. The purpose of the award is to recognise pioneering metallurgical achievements which have stimulated organised work along similar lines to such an extent that a marked basic advance has been made in metallurgical knowledge. Dr. Paul D. Merica, executive vice-president of the International Nickel Company, was the recipient of the gold medal of the A.S.M., which was established to recognise outstanding metallurgical knowledge and exceptional ability in the diagnosis and solution of diversified metallurgical problems. The A.S.M. Medal for the Advancement of Research was presented to Gwilym A. Price, president of the Westinghouse Electric Corporation. The office of president of the A.S.M. for the year 1951–1952 was taken by Professor John Chipman, Head of the Department of Metallurgy at the Massachusetts Institute of Technology.

Twin Diesel Marine Reduction Gear

THE cargo liner "Cornwall," being built at the yard of Alexander Stephen and Sons, Ltd., of Linthouse, for the Federal Steam Navigation Company, Ltd., has a length between perpendiculars of 460ft, a breadth of 62ft 6in, a depth of 40ft 3in to the shelter deck, and is designed to carry a deadweight of approximately 9800 tons on a draught of about 26ft 7in. The main propelling machinery consists of two Sulzer crosshead, two-stroke, single-acting diesel engines, each having eight cylinders of 580mm bore by 840mm stroke, with an individual scavenge pump for each cylinder, and developing 4000 b.h.p. at 225 r.p.m. Power from the two main engines is transmitted to the propeller shaft through a combined reduction gearing and hydraulic coupling, which can be seen in our illustrations, one of which shows the complete unit and the other the gearing in course of erection.

At the invitation of the Power Plant Company, Ltd., of West Drayton, we visited the company's works recently to inspect the gears for the "Cornwall," which were being prepared for testing prior to despatch to the ship. The gear unit consists of gears manufactured by the Power Plant Company, Ltd.; fluid couplings supplied by Barclay Curle and Co., Ltd., and a fabricated steel case constructed by the shipbuilders, and it is designed for a power input of 4000 b.h.p. plus 4000 b.h.p. at 217 r.p.m. and an output of 8000 b.h.p. at 100 r.p.m. The twin-engine single-reduction gear assembly has a total weight of approximately 75 tons, is horizontally disposed, and employs double helical gears. The pinion shafts are sited at 144in centres, one on each side of the main wheel, and are coupled to the main engines by fluid couplings, 3005mm in diameter, and carried on flanges 780mm in diameter. Enclosing the unit is a welded steel plate case having an average thickness of 1in which is split along the common horizontal plane of the shafts. The upper portion is of single wall box design, well ribbed to minimise resonance, and the lower section incorporates box sections under the bearing housings which are of cast steel and, together with the cast steel thrust block housing, are welded to the gearcase, while the cast steel bearing caps are independently bolted and dowelled to the lower casing.

Each pinion consists of a 55 tons per



GEARS COMPLETE

square inch heat-treated, 2½ per cent nickel-chrome-molybdenum steel rim shrunk on to a 35 tons per square inch forged steel centre, which is bored to take the transmission shaft from the couplings. These shafts are hollow, having an external diameter of 13in and a bore of 6in, and pass through the pinions to which they are connected at the aft end by turbo-pattern tooth couplings. This arrangement

GEARS BEING ERECTED

permits the pinions to centralise themselves with the main wheel when, with its shaft, it moves to the ahead or the astern position, a movement which is due to the clearance in the thrust block. The coupling design provides for free axial movement and angular flexibility by slight displacements, within the coupling, so that uniform loading across the full width of the gear teeth is ensured for either ahead or astern drive, and the possibility of any thrust being imposed on the fluid couplings is avoided. The oil supply for the hydraulic couplings is delivered through the 6in bore in the trans- mission shaft.

The wheel is of built-up design, and has a rim of 35 tons per square inch, 0·4 per cent carbon steel, and the wheel shaft, which is 35 tons per square inch steel, incorporates an integral thrust collar. The teeth of the gears are of the double helical hobbed continuous pattern, the pitch being 2 diametral pitch, the spiral angle 30 deg. and the pressure angle 20 deg. Cutting of the gears was by single start profile ground hobs having a 30 deg. helix. The overall face width is 40in and the active face width is 36in, and the pinions have been cut with ninety-one teeth, while the wheel has 196 teeth.

The bearings consist of cast steel shells lined with Admiralty grade white metal. Those carrying the pinion shaft are all 20in long, the bearings nearest the engine and at the free end are 19in diameter, and that between the coupling and the pinion is 22in diameter. There are two wheel shaft bearings, each being 20in diameter by 20in long. The thrust block has a collar diameter of 42½in and thrust surface of 650 square inches which takes an estimated load of 150,000 lb.

Forced lubrication of the gears has been adopted; the oil is drawn from a sump under the gearing by a pump through a magnetic strainer and is discharged from the pump to an Auto-Klean strainer. From this strainer the oil passes through a heat exchanger, which is cooled with sea water, and is then delivered to the gearing, while a branch leads to a gravity tank which gives a pressure of about 15 lb per square inch to the oil.

D.C. Supply Installation at Imperial College

AN interesting d.c. electrical installation, recently completed by Chloride Batteries, Ltd., is now in operation at the Imperial College of Science, Kensington. It consists of a specially constructed battery charging and control gear and has been designed to provide d.c. supplies at various voltages for students working in the college laboratory.

The original apparatus installed for this purpose had seen well over twenty years' service, and the only part of it now retained is the 110V battery consisting of fifty-five Chloride "HJG5" cells, capacity 300Ah at the ten-hour rate. This battery has been re-erected in a more convenient position and its associated apparatus dismantled to make way for a "Cycloc" automatic constant-voltage charger and a metalclad voltage selection/distribution panel that closely resembles a G.P.O. telephone switchboard. The battery is tapped at the positive end and at cells 12, 24 and 55 to give a nominal voltage range of 24V, 48V and 110V. Connected across each of the tapped sections is a "Cycloc" charger rated at 0A to 20A at 2·3V per cell and designed to maintain the output voltage at a constant level within narrow limits over a fixed range of current. Since each section of the battery is connected across its own individual rectifier, the load under normal conditions of up to 20A is supplied by that rectifier, while the cells, receiving their trickle charge at 2·3V, are maintained in a fully charged condition. All loads in excess of the maximum rectifier rating, however, are automatically transferred to the battery.

On the right of the accompanying illustration is the charging equipment, which is housed in two floor-mounted cubicles, the first containing the two rectifiers for the twelve-cell sections of the battery, and the second, the larger rectifier, across which float the remaining thirty-one cells. The rectifier and battery circuits can be isolated, if required, by means of a three-pole 60A rotary switch.

The voltage selection and distribution board, which can be seen on the left of the illustration is built of angle iron with sheet steel panels finished in stoved black enamel. Along the front are three horizontal rows of plug sockets labelled "12 cells," "24 cells" and "55 cells" respectively. The sockets in each row are wired together at the back and taken via a switch to a terminal block which is connected to the battery and rectifiers. A small shelf projecting outwards from the front of the switchboard supports a group of counter-weighted plugs numbered to correspond with the forty-seven bench positions served by the new system. By pushing the requisite bench position plugs into the correct selection sockets, therefore, a supply at any one of the three nominal volteges available can be provided at any or all of the various laboratory benches.

An Air Filter Drive

WE have received from David Brown Gears (London), Ltd., particulars of a unit using its "Radicon" worm reducing gears to give an unusually high rate of reduction. The unit concerned is a new self-cleaning air filter which has been developed, for use in cotton mills, by Northmoor Tin Works, Ltd., of Oldham. The air filter is designed to deal with the small fibres which normally permeate the air of a cotton mill, and it consists of a perforated cylinder covered with brass gauze enclosed in a galvanised iron case fitted with glass inspection panels.

In operation, air is drawn by fans through an inlet and blown against the gauze-covered, slowly revolving cylinder. The short cotton fibres carried in the air stream form a felt covering round the cylinder and this felt pad acts in turn as a dust extractor. Between the cylinder and the discharge outlet is a wooden roller fitted with rubber blades. The felt pad formed by the accumulated cotton fibres passes between these blades and is eventually deposited into a container for disposal.

The filter is driven by a ½ h.p., 1420 r.p.m. motor through two "Radicon" reducers and its speed can be adjusted from one revolution in twenty minutes to one revolution in eight hours, according to the amount of waste passing through the filter. With this drive arrangement, shown in the photograph reproduced above, the output shaft of the first worm reducing unit is fitted with a slotted disc, through which the end of a projecting arm can be adjusted. A pawl attached to the arm engages a ratchet wheel fitted to the input shaft of the second reduction unit. The arm is designed to give a variation of one to eight picks of the pawl. Final drive to the filter cylinder is through a spur pinion on the output shaft of the second "Radicon" unit which meshes with a large wheel on the cylinder.

RECTIFIER AND VOLTAGE DISTRIBUTION PANELS

AIR FILTER DRIVE UNITS

Industrial and Labour Notes

Railway Wages

At the end of last week the Railway Staff National Tribunal announced its decision concerning the railway wage claim which it was called upon to consider last month. The claim, submitted jointly by the three railway unions at the end of July, was for an increase of 10 per cent on the existing rates of pay of salaried and conciliation staff. It was refused by the Railway Executive, which made an offer of increases of approximately 5 per cent, an offer which in turn was rejected by the unions. About 442,000 salary and wage-earners are involved in the claim, which, at the request of the unions, was submitted to the Railway Staff National Tribunal.

In addition to the 10 per cent increase, the tribunal also had to consider a claim made by the Associated Society of Locomotive Engineers and Firemen for increased pay for week-end work. It was contended by the Society that week-end work involved social disabilities and should therefore be remunerated at a higher rate, and that the concession of the claim would check the flow of locomotive staff to other industries, where week-end work did not prevail. Among the arguments put before the tribunal by the Railway Executive were that the offer which it had made reasonably met the changes which had taken place in the cost of living; that the present bases of payment for week-end work were reasonable, and that the difficulties of recruiting and retaining sufficient staff were largely due to the general labour shortage and would not disappear with any reasonable increase in rates of pay.

The tribunal's findings, after full consideration of the statements of both sides, were that the existing rates of pay for conciliation and salaried staff covered by the claim should be increased by 8 per cent, as from September 3rd last; the increased rates to be taken into consideration in calculating overtime, Sunday and night duty payments. It was not recommended, however, that the increased rates should involve adjustment of present tonnage or other bonus payments. On the claim respecting week-end work the tribunal recommended additional flat-rate payments ranging from 2s. to 5s. for full turns of duty beginning on Saturday afternoons and evenings. It should be added that the tribunal's award is not binding on the unions or the Railway Executive, but since it was made known the three railway unions have intimated that it is acceptable to them. At the time of going to press the decision of the Railway Executive has not been announced.

Employment and Unemployment

The Ministry of Labour's latest report on the employment situation in Great Britain says that at the end of September the working population totalled 23,482,000 (16,031,000 men and 7,451,000 women), indicating an increase during the month of 31,000. Of that total 840,000 were serving in H.M. Forces. The number in civil employment at the end of September was 22,399,000, or 5000 fewer than at the end of August.

In the basic industries at the end of September, 4,191,000 people were employed, a number 3000 fewer than a month previously. Additions to the labour forces of transport, gas, electricity and water supply were offset by a decline in the manpower of agriculture and coalmining. In the latter industry there were 695,000 wage-earners on colliery books at the end of September, which indicated an overall loss of 2000 during the month. The labour force of the manufacturing industries, however, increased by 21,000 during September to a total of 8,746,000. By far the greater part of that increase occurred in the "metals, engineering and vehicles" group, the number employed rising by 20,000 to 4,150,000. The number of people engaged in the building and contracting industries declined during September by 3000 and there were 16,000 fewer people engaged in "professional, financial and miscellaneous services." On the other hand, there was an increase of 3000 in the number employed in Government service.

Unemployment figures included in the report relate to October 15th, on which day there were 263,756 people registered as out of work, which was 46,728 more than on September 17th. The October figure included 29,302 who were "temporarily stopped" and 50,554 married women, many of whom have probably left industry. The Ministry says that, in the week ended September 22nd, about 66,000 operatives in the manufacturing industries were on short time, each losing thirteen hours on the average, but that 1,277,000 people were working, on an average, eight hours' overtime.

National Joint Advisory Council

The Minister of Labour, Sir Walter Monckton, presided over the quarterly meeting of the National Joint Advisory Council on Wednesday of last week. The council consists of representatives of the British Employers' Confederation, the Trades Union Congress and the nationalised industries.

An official statement issued after the meeting said that the council reviewed manpower movements over the past year, the present state of the demand for labour, and the probable manpower requirements of the rearmament programme. It has been calculated that on August 29th the number of unfilled vacancies outstanding was 446,000, or 80,000 more than a year earlier. Of that total, 110,000 vacancies existed in the metals, engineering and vehicles (including aircraft) group of industries, an increase of 32,000 compared with last year. Vacancies in the principal skilled occupations in the engineering trades on August 13th numbered 36,000, an increase of 20,000 over the year. On the railways there were over 20,000 vacancies on September 26th, more than half of which were in the operating grades, including permanent way staff. At the meeting it was pointed out that against this background of labour shortage heavy and urgent demands have to be met for rearmament, for export services and for the country's basic industries. When the rearmament programme gets into its full stride it is estimated that something like 400,000 to 500,000 more workers will be needed for defence production in the manufacturing industries. Most of the expansion will be in the engineering and vehicles group, the aircraft factories and Royal Ordnance factories alone requiring to increase their labour forces by about 175,000. The Minister told the Council that he had not had sufficient time to formulate his policy for dealing with the problems associated with the manpower shortage, but as soon as he was able to do so he would consult the British Employers' Confederation, the T.U.C. and representatives of the nationalised industries and would call together his joint consultative committee.

Another matter decided by the Council was that it would recommend its constituent bodies to encourage attendance at appropriate educational courses for training in fuel efficiency.

"Fuel Economy Pays"

The Federation of British Industries has just published a booklet entitled *Fuel Economy Pays*, which is intended as a guide to the saving of industrial fuels. The advice it contains is based on the experience of the Federation's fuel advisory service, which has now been in existence for over twenty-five years.

A foreword to the booklet has been written by the director-general of the F.B.I., Sir Norman Kipping, who emphasises that there is little prospect of coal being plentiful again within the foreseeable future, and that industry must therefore look largely to economy in the use of fuel, rather than to greater supplies, as a means of increasing production. The booklet is divided into three main sections dealing with common faults in boiler operation, the use of instruments for measurement and control, and the efficient use of heat. It outlines the main causes of waste in fuel and indicates how such losses can be avoided. Most of the suggestions made in the booklet can be carried out without large capital expenditure.

Copies of the booklet can be obtained from the technical department of the Federation of British Industries, 21, Tothill Street, London, S.W.1, at 2s. each.

Export of Copper Goods

The Board of Trade has stated that from November 8th the export of some copper goods to any destination other than China or Hong Kong under open general licence is permitted only if the value of the goods exceeds the value of the copper or copper alloy content, calculated at the rate of £700 per ton for copper and £600 per ton for alloys mainly of copper. This licence applies to goods specified in group 6 (2) of the first schedule to the Export of Goods (Control) Order, 1951. Under a similar previous licence, which is revoked, the values were £500 and £400 per ton respectively. The rate has been stepped up owing to the continuing shortage and increasing price of copper and the consequent need to ensure that our exports are of corresponding high value. The general export position is that all strategic goods made of or containing copper are already controlled in that an export licence has to be obtained before they can be sent to any country except the Commonwealth and U.S.A. No goods of any kind can be exported to China or Hong Kong without an export licence.

Saving Scarce Materials

A British specialist team, led by Sir Graham Cunningham, visited the U.S.A. during the summer to investigate measures being taken and planned in the engineering industries for the conservation and efficient utilisation of scarce materials. Its report has been published this week by the Anglo-American Council on Productivity.

The team confined its attention to the engineering and allied industries, which resulted in the survey being concerned almost wholly with scarcity in supply and economy in the use of metals. The report says that, athough the team was concerned principally with economy measures useful in the short term, there was an opportunity to learn something of long-term planning of materials supplies in the U.S.A. A President's commission is making a study of the extent to which shortages of materials for production may be likely to impair economic growth or security in the U.S.A. and it is felt that the work being done by this commission will be of considerable value for the long-term future. The report sets out various conclusions and recommends that British industries should make more detailed study of measures for saving scarce materials.

Steel Distribution

During the debate in Parliament, on Monday last, on the address in reply to the King's Speech, the Minister of Supply, Mr. Duncan Sandys, said that the new Government had carefully reviewed the steel allocation scheme and had decided that it should go ahead. The scheme, which would include alloy steel, would be similar to that which operated until the middle of 1950. The necessary statutory order, the Minister added, would be issued as quickly as possible and the scheme itself would take effect from February 4th.

Notes and Memoranda

Rail and Road

SPEEDING TRACK MAINTENANCE ON BRITISH RAILWAYS.—Mr. John Elliot, the chairman of the Railway Executive, in opening a two-day exhibition of permanent way mechanised appliances, recently said that British Railways is about to introduce in four areas of the country an experimental "flying squad" system of maintenance which will revolutionise existing practices. At present, each permanent way gang, usually from four to twelve men, is solely responsible for the maintenance of a given section of the line, and the tools and methods used are very largely similar to those used for many years past. In the areas in which the experiments are to take place these gangs will be reorganised into a number of small groups and a few larger gangs of up to twenty-five men. The small groups will attend to day-to-day maintenance on a stretch of line in much the same way as at present. The larger gangs will be mobile and fully equipped with mechanical aids, and will be capable of undertaking the whole of the major maintenance work within their areas.

Air and Water

FIVE-YEAR AERIAL SURVEY CONTRACT IN IRAQ.—The Iraq Government has awarded an aerial survey contract to Hunting Aerosurveys, Ltd., of London, for the air photography and contoured mapping of a large part of Iraq. This contract is the first step in the economic development of the country, as drawn up by the Iraq Government Development Board. From the air photographs, accurate maps will be prepared which will be used for many development projects in connection with road construction, planning of water supplies, land settlement and power schemes. The photographs will also be used for preparing a geological map of the area as part of a proposed mineral survey of the country. The survey aircraft and crew have already started on the photographic operation which will take two seasons to complete. The mapping work from these photographs will be spread over a five-year period.

INSTITUTION OF NAVAL ARCHITECTS.—The following scholarships, which are tenable for three or four years, according to the length of the course at the university selected, will be offered for competition in 1952:—Naval architecture: "Institution of Naval Architects," £175 per annum; age limit under twenty-three; open to British apprentices or pupils in the Royal Dockyards or private shipyards; entries close January 15, 1952. "Trewent," £175 per annum; age limit under nineteen; open to British subjects who are, or have been, apprentices or pupils in private shipyards; entries close May 31, 1952. "Denny," £175 per annum; age limit under nineteen; tenable for four years at Glasgow University, with apprenticeship of five years; open to British subjects who have not yet begun their apprenticeship, or served not more than one year of it with Messrs. William Denny and Brothers, Dumbarton, and who have previously attended an approved public school or a school under an education authority; entries close May 31, 1952. Marine engineering: "Denny," £175 per annum; age limit under nineteen; same conditions as for "Denny" Scholarship in Naval Architecture. Full particulars of the above scholarships may be obtained from the Secretary of the Institution of Naval Architects, 10, Upper Belgrave Street, London, S.W.1.

Miscellanea

RETIREMENT OF SIR CHARLES MCLAREN.—The Ministry of Supply announces that after nearly thirteen years as director general of ordnance factories, Sir Charles McLaren, K.C.B., has retired owing to ill health. As a temporary arrangement, Mr. T. E. Harris, C.B., C.B.E., will officiate as director general of ordnance factories.

FRENCH DETERGENT PLANT.—A new detergent plant for the manufacture of "Teepol" is now in operation at Petit-Couronne, France, and has a designed capacity of 25,000 tons per annum. The project represents an association between Shell and the French chemical group Saint-Gobain, and the special feed stock, which is a cracked petroleum wax, is derived from Shell refineries.

STEEL COSTS AND REARMAMENT.—In a written Parliamentary reply, the Minister of Supply, Mr. Duncan Sandys, has stated that the increase in the price of steel approved in August is estimated to raise the cost of steel used directly in the whole rearmament programme by about £20,000,000. The higher price of steel will also increase the cost of machine tools and other plant used to produce defence equipment, but it is not possible to estimate by how much.

THE LATE MR. ALAN SINCLAIR.—We record with regret the death, on November 3rd, of Mr. Alan Sinclair, managing director of the British Tyre and Rubber Company, Ltd. He was forty-two. Mr. Sinclair had been a director of the company since 1937. He was president of the Federation of British Rubber Manufacturers' Associations in 1945–46.

BROOKHIRST JUBILEE.—The completion of major works extensions by Brookhirst Switchgear, Ltd., at Chester marks the occasion of the golden jubilee of the company which was founded over fifty years ago by the late Mr. John A. Hirst. One of the speakers at the recent opening ceremony was the chairman of the company, Mr. J. O. Knowles, who said that the extensions represented an increase of about 45,000 square feet in covered floor area, involving the assembly, test and inspection departments and including a new packing bay, a new warehouse and a large social hall.

AVIATION PETROL INGREDIENT.—It is hoped that final tests of a new ingredient, used by the research engineers of the Shell Petroleum Company, Ltd., will solve the problem of the fouling of sparking plugs in aero-engines. The flight test programme has been preceded by successful bench tests on engines using petrol to which a minute quantity of tricresyl phosphate has been added. The benefits of adding this chemical derive from its property of modifying deposits and of rendering them electrically non-conductive and non-corrosive to valve material even at high temperatures, thus reducing sparking plug trouble and exhaust valve failure.

BRITISH ENGINEERS' ASSOCIATION.—The annual luncheon of the British Engineers' Association was held at the May Fair Hotel, London, on Thursday, November 8th, and was attended by a large company of members and guests. Mr. D. D. Walker, president of the Association, was in the chair and proposed the toast of "The Guests," to which Field-Marshal Sir William J. Slim, Chief of the Imperial General Staff, responded. Field-Marshal Slim said that "British engineer," like "British soldier," was a proud title, for the reputation of British engineering was second to none. Anything done by British engineers in any part of the world was well done. But, Sir William added, engineers and soldiers had one thing in common—they could not hide their mistakes. Nowadays, he continued, the ties between engineers and soldiers had greatly increased on account of the rearmament programme, which would throw tremendous burdens upon engineers. Sir William said that he felt quite confident that all the difficulties likely to be met in the task of rearmament would be overcome by the engineering industry. Acknowledgment of the toast was also made by Mr. G. E. Beharrell, president of the Society of Motor Manufacturers and Traders, and thanks to the speakers was voiced by Mr. H. S. Broom, vice-president of the Association.

RADIO INDUSTRY COUNCIL'S PREMIUMS FOR TECHNICAL WRITING.—To encourage the writing and publication of articles reporting technical progress and development in radio and electronics in Great Britain, the Radio Industry Council proposes from January 1, 1952, to award premiums of 25 guineas each, up to six per year, to the writers of published articles which, in the opinion of a panel of judges, deserve to be commended by the industry. Thus it is hoped gradually to increase the number and standard of articles available to editors. Any non-professional writer will be eligible and the awards will be made for articles published at home or abroad in papers or periodicals which can be bought by the public on the bookstalls or by subscription. Journals circulating exclusively to members of a trade, manufacturers' journals and the privately published journals of professional institutions or learned societies will be ineligible. Writers and editors will be invited to submit published articles to the Secretary, Radio Industry Council, 59, Russell Square, London, W.C.1, for consideration, but the judges will also consider unsubmitted published articles. The judges will have the maximum freedom in choosing articles for awards, but they will be asked broadly to take into consideration: value of the article in making known British achievement in radio and electronics, originality of subject, technical interest, presentation and clarity.

Contracts

SWAN, HUNTER AND WIGHAM RICHARDSON, Ltd., has received an order from the Norwegian American Line to build a passenger liner of 17,000 gross tons, which will be propelled by two eight-cylinder Stork diesel engines built in Holland.

Personal and Business

MR. R. W. C. REEVES, M.I.E.E., has joined the board of The Belmos Company, Ltd., Bellshill, Lanarkshire.

J. H. FENNER AND CO., Ltd., has opened an additional branch at 32, Dewsbury Road, Leeds, 11, under the management of Mr. F. Grindlay.

BRITISH RAILWAYS announce the appointment of Mr. H. T. Bird, B.A., A.M.I.C.E., district engineer, Peterborough, as district engineer, Doncaster.

MR. S. F. HOLROYD and Sir John Rigby, Bart., have been appointed directors of Exors. of James Mills, Ltd., Bredbury Steel Works, Woodley, near Stockport.

HIGH DUTY ALLOYS, Ltd., states that its northern area sales office is now at Colwyn Chambers, 24, Mosley Street, Manchester, 2 (telephone, Manchester Central 2758).

THE HYDRAULIC COUPLING AND ENGINEERING COMPANY, Ltd., Isleworth, Middlesex, states that it will be known in future as Fluidrive Engineering Company, Ltd.

MR. E. H. DISCOMBE, delegate director and commercial manager of Murex Welding Processes, Ltd., Waltham Cross, Herts, has retired after thirty-five years' service with the company.

MR. P. J. SHILHAM, the assistant secretary of the Institution of Naval Architects, is retiring at the end of the year, having completed thirty-three years' service with the Institution.

MR. P. J. C. BOVILL, B.Sc., general manager of the chemicals branch of Newton Chambers and Co., Ltd., Thorncliffe, has been appointed a vice-chairman of the local board of directors.

MR. F. C. BURSTALL has been appointed joint general manager and Mr. R. H. G. Lee has been appointed export director of Automatic Telephone and Electric, Ltd., Strowger Works, Liverpool, 7.

CAMMELL LAIRD AND CO., Ltd., announces that Mr. J. C. Mather, who was appointed a director to the company in February last, has been elected chairman in succession to the late Sir Robert S. Johnson.

THE Technical and Scientific Register of the Ministry of Labour and National Service has been moved to Almack House, 26–28, King Street, St. James's Square, London, S.W.1 (telephone, Trafalgar 7020).

JAMES HOWDEN AND CO., Ltd., states that the offices of Mr. W. J. Gifford-Miles, publicity manager, and Mr. H. B. Hill, metal furniture sales manager, are now at 53, Haymarket, London, S.W.1 (telephone Whitehall 5541).

FERROUS CASTINGS, Ltd., Wilderspool, Warrington, announces that, on account of ill health, Mr. B. E. Stott has resigned his position as managing director. Mr. D. Robertson, general manager of the company, has been appointed a director.

SIR GEORGE E. BAILEY, C.B.E., M.I.Mech.E., M.I.E.E., has been elected chairman of Associated Electrical Industries, Ltd., in succession to Mr. Oliver Lyttelton, M.P., who has resigned on being appointed Secretary of State for the Colonies.

THE NATIONAL GAS AND OIL ENGINE COMPANY, Ltd., Ashton-under-Lyne, states that Mr. J. Jones has been appointed managing director, and that Mr. C. F. Barnard has been appointed a director and general manager. The Hon. A. C. Geddes has resigned from the board.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester, states that Mr. A. J. Budd, B.Sc., has been appointed assistant superintendent in the motor department. Mr. J. C. Kubale has been appointed manager of M-V-GR8, Ltd., on the retirement of Mr. P. W. Painter, director and general manager.

THE SELSON MACHINE TOOL COMPANY, Ltd., Chase Road, North Acton, London, N.W.10, states that, following the death of Mr. Frederick M. Selson on November 7th, Mr. D. W. Cooper has been appointed managing director. Mr. J. Simpson, who is a director, will undertake the duties of general manager. Mr. Cyril M. Cohen continues as chairman of the company.

HOLLOWAY BROTHERS (LONDON), Ltd., Bridge Wharf, 157, Millbank, S.W.1, states that, following the death of the chairman, Sir Henry T. Holloway, Mr. E. C. Holloway, Mr. R. E. Holloway and Mr. H. J. Holloway have resigned their positions as managing directors. They will continue to serve on the board. Mr. P. W. E. Holloway has been appointed chairman and managing director, Mr. L. J. Holloway vice-chairman and managing director, and Mr. P. H. T. Holloway and Mr. V. H. Holloway managing directors.

British Patent Specifications

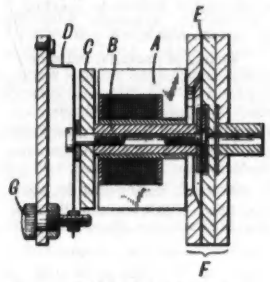
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

ELECTRICAL ENGINEERING

657,339. December 14, 1948.—Electro-Magnetic Apparatus and Electrical Vibrators, Sidney Arthur Singleton, Horace Alfred Boughton, and Singleton Bros. (Instruments), Ltd., of 53, Victoria Street, London, S.W.1.

The drawing shows the invention as applied to an electrically operated air pump, having a vibrating diaphragm and incorporating a vibrator unit. The vibrator unit has a laminated iron core *A*, mainly composed of "E" shaped stampings. A certain number of such stampings have their centre-pieces removed or, alternatively, may be of "L"-shape. In either case these stampings are placed in the centre of the lamination assembly so as to form a cavity or hollow passage, through which a connecting rod *B* composed of a non-

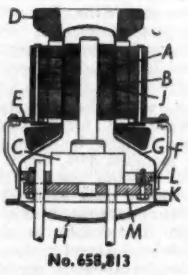


No. 657,339

magnetic material, is passed to link an armature *C* to the piece of apparatus which it is to actuate. The armature is held in its operative position by a spring *D* and is attached by a screw to the connecting rod, the other end of the rod being connected to a flexible diaphragm *E*, which is housed in the pump air chamber *F*. When the armature is attracted to the core the diaphragm expels the air from the air chamber and at the moment of repulsion the armature is assisted by the spring in its movement from the laminated core. Adjustment of the spring is provided for by a screw *G*. It is claimed that this invention utilises the maximum energy of a vibrator to provide a pushing or thrusting action along its axis. A more compact design results, since the vibrator can be directly attached by its base to the apparatus it is driving. —*September* 19, 1951.

658,813. March 12, 1949.—Construction of Motor-Driven Compressor, Therma, Fabrik für Electrische Heizung A.G., Schwanden, Canton of Glarus, Switzerland.

The invention relates to a method of constructing a motor-driven compressor in which the rotor of the electric motor and the rotary compressor coupled to it are totally enclosed in a casing and the stator of the motor lies outside this casing. The motor-driven compressor shown in the drawing has the electric motor with the rotor *A* and the stator *B* and the rotary compressor *C* arranged with the rotor on a common shaft. The



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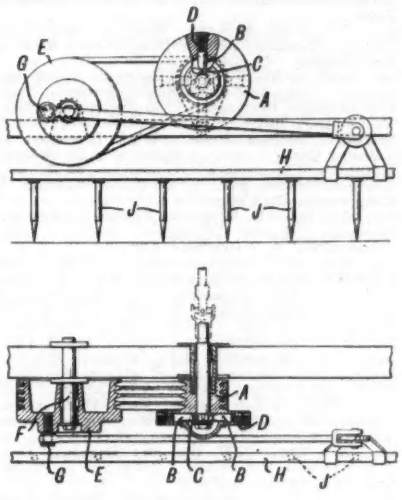
stator with the windings *D* is fixed by means of a ring *E* which is carried by arms *F* on a casing *G*. The casing encloses the rotor and the rotary compressor *C* and a closing cover *H* is welded to the flange of the casing. A narrowed cylindrical part *J* of the casing lies in the air gap of the electric motor between its rotor and stator. In a widened lower part *K* of the casing *G*, which contains the rotary compressor, is a bearing ring *L* with a machined under surface at right angles to the axis of the motor-driven compressor. The ring serves as erecting ring for the bearing plate *M* of the compressor. The suction pipe of the compressor is inserted into plate *M*, whilst the delivery pipe is welded into the closing cover *H* and passes with the inner end through a hole in plate *M*. The assembling of the motor-driven compressor is described in the specification.—*October* 10, 1951.

AGRICULTURAL ENGINEERING

657,649. February 8, 1949.—Driving Mechanism for Reciprocating Cultivators, Horstman, Ltd., James Street West, Bath, Somerset (*Inventors: Bevan Graham Horstmann and Sidney Adolph Horstmann*).

This invention comprises an improved mechanism for transmitting a mechanical drive from a rotary driving shaft to a bar or push-rod that imparts movement to the tines of a cultivator. As shown in the drawing, a driving shaft, journalled on a cross-bar of the cultivator, is coupled by means of a flexible coupling shaft to a power take-off shaft of a tractor used for operating the cultivator. The driving shaft carries a combined flywheel and vee-grooved belt pulley *A*. The wheel is rotatable on the shaft and is coupled to it by means of a shock-absorbing yielding clutch coupling comprising four spring-loaded radial plungers *B* in tubular guides on the pulley co-operating with a cam plate *C* on the shaft. The wheel drives through vee belts a second combined flywheel and pulley *E* mounted on a spindle *F*.



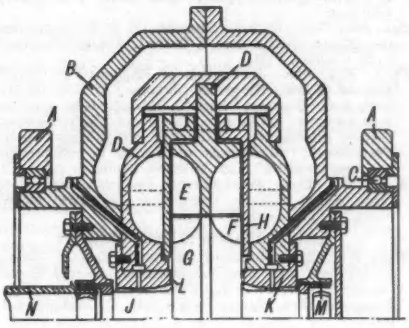
No. 657,649

This wheel is of larger diameter than the wheel *A* and rotates at about half its speed. A crank-pin *G* fixed to the wheel is coupled by means of a connecting-rod to a transverse bar or push-rod *H* so that a transverse reciprocating movement is transmitted by the crank and connecting rod. The tines or other ground working tools *J* of the cultivator are attached directly to the transverse rod. The wheel *E*, being constructed as a flywheel, tends to maintain a constant speed of rotation and thus minimises shock due to the taking up of back lash in the transmission as the reciprocating part of the mechanism accelerates and decelerates. By the use of the further flywheel *A* arranged to drive the directly-coupled flywheel *E*, the total flywheel effect is increased considerably without damage to the tines or other tools when they encounter an obstruction. The shock-absorbing yielding clutch coupling between the driving shaft and the wheel further reduces shock in the transmission mechanism. Instead of using a yielding clutch a resilient coupling comprising driving and driven members coupled together by a resilient member may be used.—*September* 26, 1951.

INSTRUMENTS AND TESTING PLANT

657,786. November 30, 1948.—Fluid Dynamometers, Power Jets (Research and Development), Ltd., 25, Green Street, London, W.1 (*Inventor: Robert Bassett Reynolds*).

The invention proposes apparatus for the absorption and measurement of power at high rotational speeds. It comprises a fluid absorption dynamometer having its rotor supported between bearings axially separated substantially only by the rotor itself. There is no effective fluid seal between the rotor and its bearings. One fluid supplied to the dynamometer provides for both lubrication of the bearings and the transmission of torque from the rotor to the stator, the dynamometer being connected for the supply of the fluid in a closed system which includes a heat exchanger for extracting heat from the fluid. As shown in the drawing, the dynamometer comprises stationary pedestals *A* in which a casing *B* is supported by bearings *C*. The casing *A*, although primarily a stationary element, is free to move rotationally. The casing encloses the stator members *D*, which



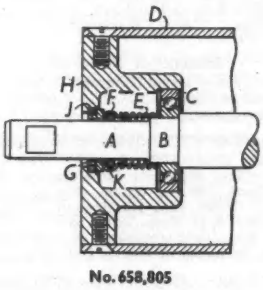
No. 657,786

co-operate with one another and are shaped to afford substantially enclosed cavities *E* for the torque transmitting fluid, the cavities being completed by appropriately shaped recesses *F* formed in the periphery of a rotor *G*. Sluice plates *H* are movable to vary the power absorption capacity of the machine. The rotor has integral stub shafts *J* mounted in journal bearings *K* and supported by the outer pair of stator members *D* from the casing. The journal bearings are arranged in close axial proximity with the rotor and are provided with locating pads *L*. Although the bearings are each provided with a fluid lubricant supply channel, no seal is provided between the bearing lubricant and the torque transmitting fluid in the cavities, since the same fluid lubricant is used. In these respects the machine differs from a conventional machine of the same kind and is enabled, by virtue of the resultant compact positional relationship of the rotor *G* and its bearings *K* to operate with extremely high rotational speeds. Seals *M* are provided at the ends of the rotor stub shafts *J* to oppose leakage of fluid from the machine. The rotor is driven through the shaft *N*, which is connected by splines to the rotor stub shaft.—*September* 26, 1951.

MISCELLANEOUS

658,805. January 20, 1949.—Mechanical Seals between Relatively Rotating Parts, Flexibox, Ltd., Twining Road, Trafford Park, Manchester, 17 (*Inventor: Frederick Benjamin Porges*).

This invention is a modification of that described and claimed in specification No. 622,141. As the drawing shows, the roller shaft *A* is stationary and has a part *B* on which the ball bearing *C* for the roller *D* is positioned, upon which one end of the coil spring *E* is an interference fit. The other end of the spring is an interference fit on a sleeve



No. 658,805

extension of a stationary seal ring *F*, which presses upon a rotary seal ring *G* between which and a part *H* of the roller construction is a packing-ring *J*. There is a packing-ring *K* between the stationary seal ring *F* and the shaft. The fact that the spring is an interference fit on both the part of the shaft and on the stationary seal ring ensures that the ring is held stationary whichever be the direction of rotation of the roller. There are similar seals at each end of the roller and the space between is filled with lubricant for the ball races, which is prevented from escaping by the seals.—*October* 10, 1951.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

To-day, Nov. 16th.—LIVERPOOL BRANCH: Service Centre, 9, Whitechapel, Liverpool, "Television," P. S. Hersey, 7.30 p.m.

Sat., Nov. 17th.—OXFORD BRANCH: S. E. B. Demonstration Room, George Street, Oxford, "Space Heating," C. B. Cleland, 3 p.m.

Tues., Nov. 20th.—Institution of Engineers in Charge, Magnet House, Kingsway, London, W.C.2, "High-Frequency Heating," M. O'C. Horgan, 6.30 p.m.——PORTSMOUTH BRANCH: Divisional Headquarters, British Electricity Authority, 111, High Street, Portsmouth, "Diagnosis of Faults in Fluorescent Lighting Circuits," A. G. Mitchell, 8 p.m.

Wed., Nov. 21st.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "Control Equipment," G. T. Maycock, 7.30 p.m.

British Institution of Radio Engineers

Wed., Nov. 21st.—LONDON SECTION: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1, "Developments in High-Frequency Transmitter Cables," R. C. Mildner, 6.30 p.m.

British Society of Rheology

Fri., Nov. 23rd.—Institute of Physics, 47, Belgrave Square, London, W.1, "Soil Mechanics," J. Evans and P. Payne, 2.30 p.m.

Chadwick Trust

Tues., Nov. 20th.—Royal Sanitary Institute, 90, Buckingham Palace Road, London, S.W.1, "The Health of Cities: Some Problems Arising from Congestion and Overbuilding," William Holford, 2.30 p.m.

Illuminating Engineering Society

Mon., Nov. 19th.—SHEFFIELD CENTRE: The University, Western Bank, Sheffield, 10, "Home Lighting," Miss Wardlaw, 6.30 p.m.

Wed., Nov. 21st.—TEES-SIDE GROUP: Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Lighting and the Contractor," W. E. Dalby, 6.30 p.m.

Thurs., Nov. 22nd.—BRADFORD GROUP: Yorkshire Electricity Board, 45–53, Sunbridge Road, Bradford, "The Lighting of Departmental Stores," C. R. Bicknell, 7.30 p.m.

Institute of British Foundrymen

Sat., Nov. 17th.—BRISTOL AND WEST OF ENGLAND BRANCH: Grand Hotel, Broad Street, Bristol, "Production of Heavy Castings for Electrical Equipment," N. Charlton, 3 p.m.

Wed., Nov. 21st.—LONDON BRANCH: Waldorf Hotel, Aldwych, W.C.2, "Problems: Recruitment and Apprentices," A. Talbot, 7.30 p.m.——N.E. SCOTTISH SECTION: Imperial Hotel, Keptie Street, Arbroath, "Foundry Sand Control Technique," W. Y. Buchanan, 7.30 p.m.

Institute of Industrial Supervisors

Mon., Nov. 19th.—DUDLEY SECTION: Technical College, Dudley, "Publicity and Works Information," H. R. Viner, 7.30 p.m.

Wed., Nov. 21st.—BRISTOL SECTION: Grand Hotel, Bristol, "Welfare: Safety and Supervision," I. E. Baggs, 7.30 p.m.

Thurs., Nov. 22nd.—S. WALES AND MONMOUTHSHIRE SECTION: Kayser Bondor, Ltd., Merthyr Tydfil, "Time Study in Practice," W. E. Bradshaw, 7 p.m.

Institute of Marine Engineers

To-day, Nov. 16th.—Technical Institute, Falmouth, "The Construction of Oil Tankers," H. Armstrong, 7.30 p.m.

Institute of Metals

Thurs., Nov. 22nd.—BIRMINGHAM LOCAL SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Metal Economics," A. J. Murphy, 7 p.m.

Institute of Navigation

To-day, Nov. 16th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Recent Work on Polar Navigation," L. Foster, 5 p.m.

Institute of Road Transport Engineers

Tues., Nov. 20th.—N.E. CENTRE: Dunelm Hotel, Durham City, "Vehicle Development during the Last Decade," W. C. Wilson, 7 p.m.——MIDLANDS CENTRE: Crown Inn, Birmingham, "Vacuum and Air Brakes," S. H. Edge, 7.30 p.m.

Wed., Nov. 21st.—N.W. CENTRE: Victoria Hotel, Wigan, "The Performance of Heavy Duty Oils," M. Towle, 7 p.m.

Thurs., Nov. 22nd.—LONDON CENTRE: Royal Society of Arts, John Adam Street, London, W.C.2, "The Trend of Brake Design as it Affects Service," J. W. Kinchin, 6.30 p.m.

Institution of Civil Engineers

Wed., Nov. 21st.—N.W. ASSOCIATION: 9, The Temple, 24, Dale Street, Liverpool, "Prestressed Concrete Bridges and Liquid Retaining Structures," J. W. A. Ager, 6 p.m.

Institution of Electrical Engineers

Mon., Nov. 19th.—Savoy Place, London, W.C.2, Discussion on "Light Electrical Engineering and the Mechanical Engineer," opened by T. E. Goldup, 5.30 p.m.——LONDON STUDENTS' SECTION: George Hotel, Reading, "Medical and Industrial Uses of Radio-Frequency Energy," H. Burton, 7 p.m.

Tues., Nov. 20th.—E. MIDLAND CENTRE: E. Midland Electricity Board Service Centre, Derby, "Diesel Locomotives," A. P. Goodman, 6.30 p.m.

Fri., Nov. 23rd.—N.E. STUDENTS' SECTION: Grey Hall, King's College, Newcastle upon Tyne, "Experiences on an Australian Distribution System," E. G. Williams, 6.30 p.m.

Institution of Engineering Draughtsmen and Designers

To-day, Nov. 16th.—LONDON AREA: Room 310, London School of Tropical Medicine, London University, "The American Approach to Productivity," R. D. Chapman, 7 p.m.

Sat., Nov. 17th.—GLOUCESTER BRANCH: Works Visit to the Gloucester Railway Carriage and Wagon Co., Ltd., Gloucester, 10 a.m.

Fri., Nov. 23rd.—LIVERPOOL BRANCH: Exchange Hotel, Liverpool, Special Branch Meeting, 7 p.m.——GLASGOW BRANCH: Royal Hotel Lounge, Glasgow, Special Branch Meeting, 7 p.m.

Institution of Engineering Inspection

Wed., Nov. 21st.—DUNDEE BRANCH: School of Economics, Dundee, "Plastics," J. Mulvey, 7.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tues., Nov. 20th.—39, Elmbank Crescent, Glasgow, "The History and Development of Machinery for Paddle Steamers," G. E. Barr, 6.30 p.m.

Institution of Locomotive Engineers

Wed., Nov. 21st.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, "Diesel Rail Traction," R. W. Stuart Mitchell, 5.30 p.m.

Institution of Mechanical Engineers

To-day, Nov. 16th.—Storey's Gate, St. James's Park, S.W.1, Thomas Hawksley Lecture, "Some Fuel and Power Projects," H. Roxbee Cox, 5.30 p.m.——SOUTHERN BRANCH, GRADUATES' SECTION: University College, Southampton, "Photo-Elasticity," J. Brabone, 7 p.m.

Sat., Nov. 17th.—MIDLAND BRANCH, GRADUATES' SECTION: Morning Visit to British Thomson-Houston, Ltd., Rugby.

Mon., Nov. 19th.—MIDLAND BRANCH, GRADUATES' SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Engineering Failures," D. Dudgeon Stockley, 6.30 p.m.——DERBY A.D. CENTRE: Midland Hotel, Derby, Discussion on "Racing Cars," 7 p.m.——SCOTTISH A.D. CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, paper by the Centre Chairman, A. Craig MacDonald, 7.30 p.m.

Tues., Nov. 20th.—E. MIDLANDS BRANCH: Electricity Showroom Theatre, Trongates, Derby, "Diesel Locomotives," A. P. Goodman, 6.30 p.m.

Wed., Nov. 21st.—SCOTTISH BRANCH, GRADUATES' SECTION: Visit to Stewarts and Lloyds, Ltd., Clydesdale Tube Works, Coatbridge, 7.15 p.m.——SOUTHERN BRANCH: Royal Aircraft Establishment Technical College, Farnborough, "Some Problems in the Manufacture of Experimental Gas Turbines," L. H. Leedham, 7.15 p.m.——N.E. A.D. CENTRE: The University, Leeds, Discussion opened by Centre Chairman, H. N. Tuff, 7.30 p.m.——N.W. A.D. CENTRE: Engineers' Club, Albert Square, Manchester, Annual Dinner, followed by "Experiences during Twenty Years of Oil Engine Development," C. B. Dickson.

Thurs., Nov. 22nd.—N.W. BRANCH: Engineers' Club, Albert Square, Manchester, "Designing for Production," C. A. Sparkes, 6.45 p.m.

Fri., Nov. 23rd.—Storey's Gate, St. James's Park, London, S.W.1, "The Control of Boilers Fired by Solid Fuels in Suspension," Llewellyn Young, 5.30 p.m.——WESTERN BRANCH, GRADUATES' SECTION: College of Technology, Unity Street, Bristol, "Design Development of the Aircraft Gas Turbine," B. A. Peaster, 7 p.m.

Institution of Post Office Electrical Engineers

Wed., Nov. 21st.—Conference Room, Fourth Floor, Waterloo Bridge House, London, S.E.1, "Telecommunications in Aviation," W. P. Nicol, 5 p.m.

Institution of Structural Engineers

Wed., Nov. 21st.—YORKSHIRE BRANCH: Great Northern Hotel, Leeds, "The Baitings Reservoir," T. E. S. White, 6.30 p.m.

Thurs., Nov. 22nd.—11, Upper Belgrave Street, London, S.W.1, "The Structural Engineer as Arbitrator, Expert Witness and Advocate," Gower Br. Pimm, 5.55 p.m.

Fri., Nov. 23rd.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, "Designing for Welding," F. Brooksbank, 6 p.m.

Iron and Steel Institute

Wed. and Thurs., Nov. 21st and 22nd.—4, Grosvenor Gardens, London, S.W.1, Autumn Meeting, 1951.

Junior Institution of Engineers

To-day, Nov. 16th.—39, Victoria Street, London, S.W.1, Chairman's Address, "Cranes and Lifting Machinery," P. B. Hebbert, 6.30 p.m.

Sat., Nov. 17th.—N.W. SECTION: Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester, Film, "Distinguished Company," 2.30 p.m.

Fri., Nov. 23rd.—39, Victoria Street, London, S.W.1, Annual General Meeting, to be followed by the Annual General Meeting of the Contributors to the Benevolent Fund, 6.30 p.m.

Liverpool Joint Chemistry Committee

Wed., Nov. 21st.—Grosvenor Hotel, Chester, "Industrial Applications of Spectroscopy," J. G. Reynolds, 7 p.m.

Manchester Association of Engineers

To-day, Nov. 16th.—Engineers' Club, Albert Square, Manchester, "Engineering Inspection and Metrology," W. E. Landon, 6.45 p.m.

Newcomen Society

Wed., Nov. 21st.—Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, Annual General Meeting, "Peter William Willans (1851-1892)," K. W. Willans, 5.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Fri., Nov. 23rd.—Mining Institute, Neville Hall, Newcastle upon Tyne, "An Analysis of Ship Vibration Using Basic Functions," J. E. Richards, 6.15 p.m.

Royal Aeronautical Society

Thurs., Nov. 22nd.—St. Mary's College, Cheltenham, "Problems of Transonic Flight," A. N. Clifton, 7.30 p.m.

Royal Institution of Great Britain

To-day, Nov. 16th.—21, Albemarle Street, London, W.1, "New Materials in Engineering," T. E. Allibone, 9 p.m.

Fri., Nov. 23rd.—21, Albemarle Street, London, W.1, "Radio-Astronomy," J. A. Ratcliffe, 9 p.m.

Royal Meteorological Society

Wed., Nov. 21st.—49, Cromwell Road, London, S.W.7, "A Study of Cold Fronts Over the British Isles," H. W. Sansom; "The Apparent Diurnal Temperature Variation in the Lower Stratosphere," R. H. Kay, 5 p.m.

Royal Society of Arts

Wed., Nov. 21st.—John Adam Street, Adelphi, London, W.C.2, "The Reclamation of Abandoned Industrial Areas," L. Dudley Stamp, 2.30 p.m.

Sheffield Society of Engineers and Metallurgists

Mon., Nov. 19th.—The University Building, St. George's Square, Sheffield, "American Alloy Steel Rolling Practice," R. Stewartson, 7.30 p.m.

Society of Chemical Industry

Tues., Nov. 20th.—Geological Society, Burlington House, Piccadilly, London, W.1, "Recent Trends in Chemical Engineering," D. M. Nowitt, 5.30 p.m.

West of Scotland Iron and Steel Institute

To-day, Nov. 16th.—39, Elmbank Crescent, Glasgow, "Basic Refractories," W. F. Ford, 6.45 p.m.

Women's Engineering Society

Thurs., Nov. 22nd.—MANCHESTER BRANCH: Visit to Dunlop Rubber Company, Manchester, 6.30 p.m.

Codes of Practice

The Codes of Practice Committee for Civil Engineering Public Works and Building and Constructional Work is under the ægis of the Ministry of Works. Codes are issued on behalf of the Committee by the British Standards Institution, 24–28, Victoria Street, London, S.W.1.

COPPER COVERINGS FOR ROOFS

Code 143.104 (1951). The Council for Codes of Practice for Buildings has now issued this Code in final form. Drawn up by a committee convened by the Royal Institute of British Architects on behalf of the Council, the Code is a revision, following comment received, of the draft previously issued. This Code deals with copper sheet coverings for roofs, including such flashings and gutters as are an integral part of the roof construction. Recommendations are made for the selection of sheeting, and detailed information is given regarding the technique of laying and the preparatory work entailed. Attention is paid to the fashioning of the sheeting in the covering of rolls and square abutments, the provision and placing of parapet gutters and outlets, and the use and spacing of clips. Many of the details associated with the laying of the roofing are illustrated in a series of drawings. There are appendices dealing with gauges, thicknesses and weights of copper sheet, and the physical properties of copper. The Code carries the usual warning that, in the present abnormal conditions, it may not be practicable to carry out all the recommendations. Price 4s., post free.

Launches and Trial Trips

RONDEFJELL, fore part of motor tanker; built by John Crown and Sons, Ltd., for Olsen and Ugelstad, Oslo; after end of vessel launched April 9th; length between perpendiculars 565ft, breadth moulded 74ft 9in, depth moulded 35ft 10in, deadweight 23,000 tons. Launch, October 15th.

JUAN PERON, whale factory ship; built by Harland and Wolff, Ltd., for the Compania Argentina de Pesca; length between perpendiculars 635ft, breadth moulded 80ft, depth to tank deck 36ft, depth to flensing deck 61ft, deadweight 25,324 tons; flensing deck 323ft by 80ft, factory 358ft by 80ft; steam deck machinery, ship's complement 484; two Harland-Burmeister and Wain single-acting, four-cycle diesel engines, six cylinders, 740mm diameter by 1500mm stroke, 110 r.p.m., five 425kW, 220V d.c. generators, two 120kW, 110V d.c. generators. Trial, October 16th.

SURREY, cargo liner; built by Alexander Stephens and Sons, Ltd., for the Federal Steam Navigation Company, Ltd.; length 469ft 6in, breadth 64ft 6in, depth 42ft, deep load draught 27ft 4in, deadweight 10,780 tons; five cargo holds, one heavy derrick, 30 tons capacity. Launch, October 17th.